THE MONTHLY

Review

MAR 5 1946

Official Organ of the American Electroplaters' Society
A Society for the Advancement of the Science of Electroplating

FEBRUARY ✦ ✦ ✦ 1946

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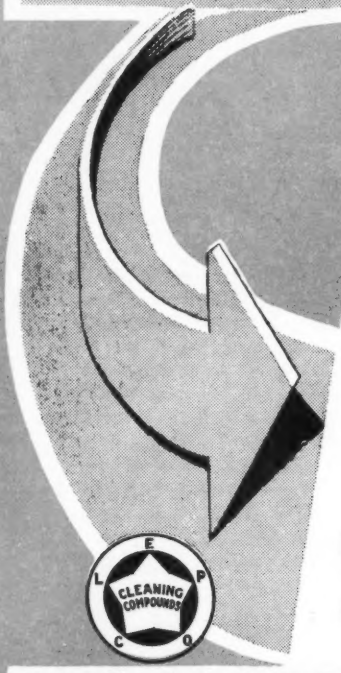

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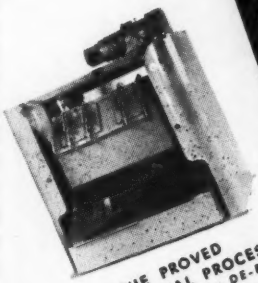

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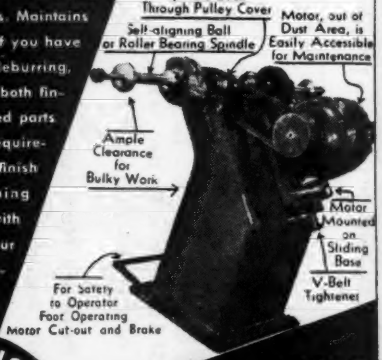
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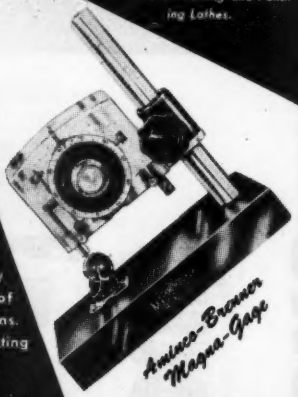

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THE MONTHLY

Review

VOLUME 33 • FEBRUARY • NUMBER 2

Published Monthly at
92 JEFFERSON ST., PATERSON, N.J.
by AMERICAN ELECTROPLATERS' SOCIETY

P.O. Box 168
Jenkintown, Pa.
Phone: Ogontz 4663

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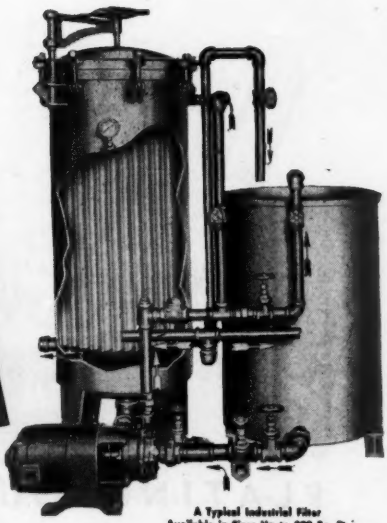

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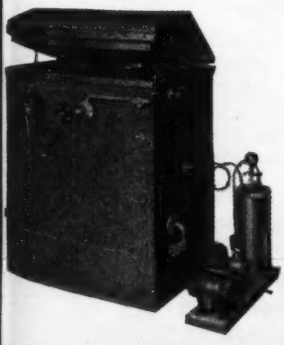

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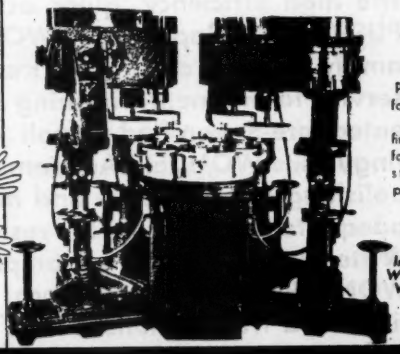

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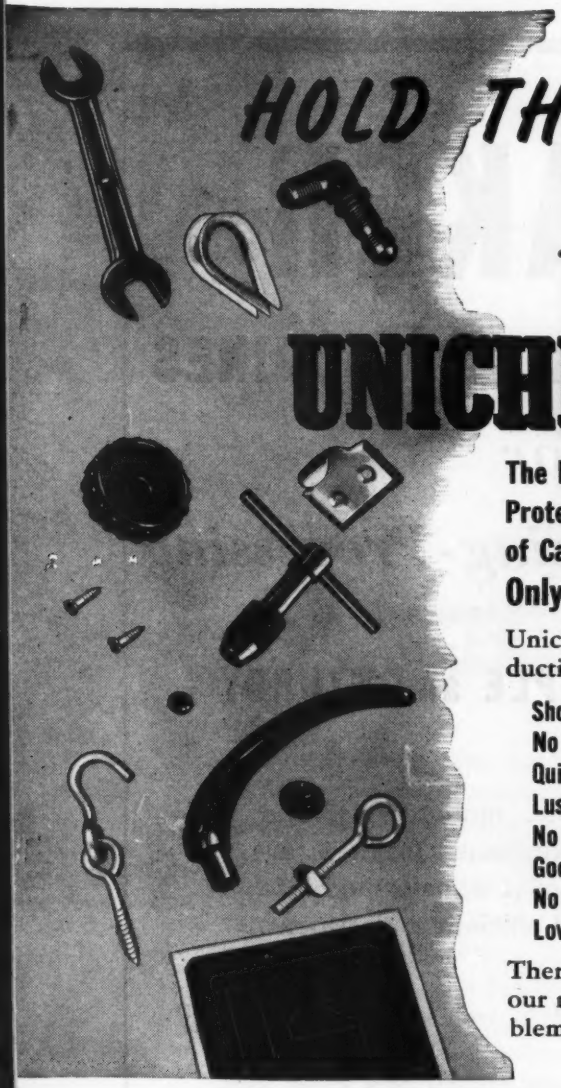

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A.E.S. *Research Projects*

THEIR SIGNIFICANCE

MANY prospective Sustaining Members are willing to subscribe to the A.E.S. Research Fund provided it can be shown that the Research Program will be of direct value to them. In the event that the listing of the projects by title, appearing elsewhere in this issue, does not convey sufficient explanation to a prospective Sustaining Member, the following comments are offered on their significance to the plating industry as a whole.

Project No. 1

"Stripping of Copper from Various Base Metals" deals with a problem that confronts all firms using copper plating. The objectives of the investigation are to determine how rapidly known stripping processes function, their relative economics, the extent to which the base metal surface is etched and the surface finishing required after stripping before replating.

Project No. 2

"Determination of Impurities in Electroplating Solutions", is of importance to all concerns doing electroplating. The advent of bright plating and the demand for high speed plating has emphasized the importance of maintaining impurities in plating baths at extremely low values. The objective of this project is to obtain information on the best methods of analysis for small quantities of impurities in various plating baths. This not only involves determination of the most rapid method but also the relative accuracy of available methods. A by-product of this investigation to date is the development of new methods for certain impurities.

Only such methods are being studied which do not require prohibitively expensive apparatus or operators with skill beyond that normally present in the average manufacturing concern.

Project No. 3

"Methods for Testing Adhesion", is of fundamental importance to the manufacturer of any plated products which must meet rigid specifications. Progress in research on proper cleaning methods and optimum plating conditions has been restricted in the past because of lack of adequate tests for adhesion. Publication of the preliminary survey is known to have stimulated at least one manufacturer to refine one method to the point that it can be used as a reliable index of the adequacy of the cleaning prior to plating.

Project No. 4

"Effect of Surface Finishing of Non-Ferrous Base Metals on Protective Value of Plated Coatings", should be of interest to all manufacturers of non-ferrous products on which plated coatings are applied for sales appeal or protective value. This investigation is expected ultimately to cover zinc base die castings and aluminum, magnesium and copper base alloys.

Project No. 5

"Effect of Impurities and Purification of Electroplating Solutions", is designed to give much needed information to the plating industry. The results of this investigation will enable manufacturers to establish more practical specifications governing impurities and, by improving the purification techniques, will also enable them to more readily meet these specifications.

Project No. 6

"The Nature and Effect of Porosity in Electrodeposits", is of fundamental importance in our effort to produce more corrosion resistant coatings. All electrodeposits are porous or contain potential pores which develop in service and lead to ultimate

failure. If a non-porous coating could be deposited, much thinner deposits could be applied with an increase in productive capacity of existing equipment, saving in metal costs and improvement in product quality. These objectives are most certainly of interest to all manufacturers of plated parts.

Project No. 7

"Methods for Testing Thickness of Electrodeposits", is valuable where thickness measurements are required as a part of meeting specifications. Thickness is directly related to the quality of plated products and while the microscope, dropping tests and magnetic methods have been applied in such measurements, the limitations of these methods in their present state of development are not generally recognized.

The microscope method is generally applicable to all thicknesses. However, it is time consuming, requires special skill for reliable results, and is destructive. The magnetic methods are non-destructive, but are limited as to the thickness of the coating to which they can be applied, and their accuracy may be affected by residual magnetism in steel products.

In view of limitations as these and the demand for heavier plated coatings, specified by manufacturers to improve quality, new methods of measuring thickness must be developed or existing methods improved.

Project No. 8

"Polarization at Electrodes in Electroplating Processes", is a study of a fundamental factor in all electroplating operations. Much has been published on the subject, but there is still much to be learned which would be practical benefit in both electropolishing and electroplating processes. One need only point to the oft repeated statements of the directors of research of firms like the General Electric Company, General Motors Corporation and others, as to the ultimate value of fundamental research, as further emphasis of the importance of this type of investigation to the electroplating industry.

Elsewhere in this issue is listed the personnel of the A.E.S. Research Committee and its sub-committees. A total of about fifty individuals is involved most of whom have a lifetime of experience in research matters. Their combined talent and experience could not be purchased at any practical figure. With the exception of the project directors and research fellows, the other members of the organization are contributing their time and experience to the Program without compensation from Society or industry.

A. K. GRAHAM, *Executive Secretary*

☆

Sustaining Membership Campaign

☆

OUR Research Program is now going into high gear with eight projects in various stages of development as shown by the Research Committee Report in this issue. This program was made possible through the creation of the A.E.S. Research Fund, subscribed by Society members and Branches as well as by industrial concerns. Maintenance of this fund is now very largely dependent upon Sustaining Memberships, each representing a minimum subscription of $100.00 annually.

The Research Program includes in its scope both fundamental and practical problems, the solutions of which promise to be of great value to manufacturers as well as to individual members. The four hundred Sustaining Members required to insure the continuance of this program should be readily obtained. This only means one Sustaining Member for every ten members of the Society. The Branch Research Chairmen have been advised of their quotas. The members are urged to sell this program to industrial concerns in their area by personal calls and all other means.

The Finance Sub-Committee consisting of M. R. Caldwell, Chairman, W. E. Moline, R. Sizelove and T. A. Trumbour have organized the Sustaining Membership Cam-

paign through the Branch Societies and supplied the necessary information and instructions. However, Branch quotas will not be met unless the individual members of the Branch Committees are fully informed of how to do the job and are fully sold on the value of the Research Program. Each Branch President is therefore urged to call a meeting of his Research Committee to assist in organizing and conducting the local campaign. If further information or assistance is needed, members of the Finance Committee should be contacted. Reference should also be made to the editorial on "A.E.S. Research Projects — Their Significance" appearing in this issue.

A list of the Sustaining Memberships obtained by the Branches will be published shortly. Approximately one-third of the required number has been obtained. Some Branches have nearly made their quota while others have shown no results to date.

Let us renew our efforts and put the Research Program over. It is worth selling. Sell it through Sustaining Memberships!

M. R. CALDWELL, *Chairman*
Research Finance Sub-Committee

Volunteer A Volume

HAVE you ever been in serious need of a very early issue of MONTHLY REVIEW or the PROCEEDINGS . . . and to find it canvassed libraries or written a score of friends only to run up against a stone wall. Such a situation is tremendously aggravating especially when you realize someone, perhaps even nearby, would be glad to loan you the copy if they knew of your need.

In recent years the number of instances of this kind have multiplied rapidly. This condition results from two factors. In the first place as our industry has expanded with emphasis on its special science, there has been a growing appreciation of the value of work recorded in the earlier issues of A.E.S. publications. Their reference demand has increased considerably. In the second place, existing copies are extremely limited because print orders in those days were so much smaller.

For the benefit of all of us, as well as to uphold the prestige of the A.E.S. as a full fledged scientific society, we have the moral responsibility to gather existing copies, and establish complete sets at locations which will provide accessibility, and therefore utility, for the greatest number of members.

After thoughtful consideration your Executive Committee has decided the practical answer to the problem is to provide as complete sets as possible for a selected library in every city where the Society has a Branch. Since most of these libraries have photostating service, copies of references can be made available at relatively low cost.

Success of this plan depends upon cooperation of every number. Examine the list of back numbers needed, as given below and tells us which you can donate of PROCEEDINGS, REVIEW, or both.

The plan is already working. F. F. Pierdon, Baltimore-Washington Branch, has donated his 1921-1945 volumes of the MONTHLY REVIEW, which with few exceptions are complete. George B. Hogaboom has agreed to supply extra copies of his publications.

The following back volumes of the MONTHLY REVIEW are needed:

All issues from 1913 to 1931 inclusive and for 1940 and 1941.

A limited number of issues for the years 1932 to 1939 inclusive and for 1942 and 1943 are required.

Annual PROCEEDINGS for all the years prior to 1943.

If you can help in this worthy undertaking, write the Secretary's Office, P.O. Box 168, Jenkintown, Pa., listing the volumes and issues you can donate.

Shipping instructions will then be sent you and all postage or express charges will be paid by the Society.

Let's have your prompt and generous response.

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CARL E. HEUSSNER

Materials Engineer
CHRYSLER CORPORATION

Chairman
A.E.S. RESEARCH COMMITTEE

CARL states that he was born *about* September 15, 1899 on a farm in northern Michigan. Being a true scientist he does not claim to personally remember the exact date.

After attending a country school and then the high school in Marlette, Mich., he enlisted in World War I. Following the war he attended Albion College, University of Michigan and Wayne University. This migration was not due to football as one might suppose, but rather to a change from medicine to training better suited to his ultimate life's work.

Joining the Chrysler Corporation after graduation, Carl has grown with the plating industry during a period in which rule of thumb practice has been supplanted by scientific control and electroplating has become an engineering science. He has contributed much to this advancement, through work within his company and through active participation in technical society work that ordinarily leave him relatively little time for other things. But as we shall see anon, with all of this heavy work load he still manages a little time for the pleasantries of life.

Operating inconspicuously in most instances, he has been very active in the A.E.S., having served on the Research Committee from its beginning. He was responsible for reorganizing this committee's activity in 1945 and under his able leadership the A.E.S. Research Program has been established on a sound foundation.

He was one of the small group responsible for establishing Committee B-8 on Electrodeposited Metallic Coatings of the A.S.T.M., and has been an active worker since its formation.

He has been conspicuously identified with promotion of the use of zinc base die castings and improvement in their quality through various society committees and served as consultant to the War Production Board on these matters.

He pioneered the development of specifications for electroplating and finishing processes and products. Much of the improvement in the quality of plated products in recent years has resulted from this effort.

In his position as Materials Engineer of the Chrysler Corporation he has developed a profound knowledge of many materials and their applications, not directly related to electroplating. The Societies with which he has been conspicuously identified, such as the American Electroplaters' Society, American Chemical Society, Electrochemical Society, American Society for Testing Materials, Detroit Engineering Society, American Ceramic Society and the Electrodepositors' Technical Society, give an indication of the scope of his interests and activities.

On the lighter side Carl is also quite versatile in his extra-curricular activities. For example there are probably very few members of the Society with whom he has not placed a football bet on one or more occasions. One ventures to suggest this might be more profitable than the stock market.

It is understood that he is a formidable opponent at pinochle. Proof of this is the fact that such experts as Red Wilson, George Nankervis and Mose Cherry have allowed him to play in their league for many years.

At bridge his record might not be so successful. The Secretary still recalls how on one occasion he had to mis-bid in order to save Carl the humiliation of losing a game and three-quarters of the Chrysler Corporation. Confidentially, this is probably the reason that he hasn't played bridge with the Secretary since.

There is also the story of a certain young lady in the East who beat Carl in a steamed clam eating contest by using production methods which were unknown to him at the time. This is an unusual circumstance because there are many who will testify that Carl's capacity for good food is hard to match.

It is also known that Carl is interested in hunting, but the Secretary has yet to receive a picture of him actually bagging a brace of pheasants or hurdling a split-rail fence.

Needless to say Carl has made a host of friends in the Society and his personal contribution to all of its activities, serious and otherwise, have been very considerable.

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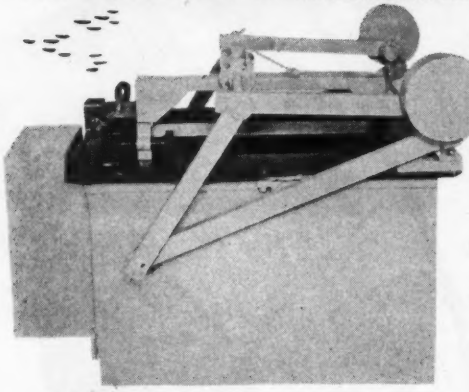

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Silver Plating AIRCRAFT ENGINE BEARINGS

by JOHN S. HART and C. E. HEUSSNER
Chrysler Engineering Laboratories

DURING the early days of the war the Chrysler Engineering Laboratories started a study of how to deposit heavy silver coatings for bearings. An investigation was undertaken to learn how to produce both good adhesion and high quality deposits. When these two goals were achieved, a study was made of some of the physical properties of the electrodeposited silver metal and the silver to steel bond as affected by annealing. Some very interesting results have been obtained.

ADHESION OF SILVER TO STEEL

This work fell naturally into several different phases. The first of these was to develop a method of obtaining consistently perfect adhesion. By this is meant that the silver to steel bond must always be stronger than the tensile strength of the silver metal. The problem of obtaining adhesion was approached in two ways: with silver direct on steel, and with an intermediate strike layer of another metal.

Silver Direct on Steel

The initial experiments were carried out by applying silver strike deposits directly to the steel and following them with the normal deposits. The adhesion obtained in this manner was good, but not perfect. It was found that the deposits would separate from the base metal at a tensile load of about 20,000 psi. Two bearings which were plated by this technique gave good service in engine tests, but it was thought that a better process could be worked out which would be easier to control, and which would give more consistent results.

Intermediate Coatings

Both copper and nickel were tried as an intermediate layer between the silver deposit and the steel. The use of the copper was found to result in the formation of a diffusion alloy of silver and copper which is known to be brittle. For this reason little work was carried out on this process. The remaining effort was put on the use of a nickel strike whereby perfect adhesion was obtained. It should be noted that the adhesion was stronger than the silver deposits both in the plated condition and after annealing at 950°F for one hour. At no time was poor adhesion noticed before the annealing operation. Tests showed the bond strength to be in excess of 50,000 psi before annealing, 35,000 afterwards.

Methods of Test

It is in order here to say a word about the method of testing adhesion used in this work. The test was a minature adaptation of the Ollard test. The samples were ¼ inch in diameter and had a wall thickness of .010 inch. Because of this thin wall the minimum thickness of deposits required for satisfactory testing was only .020 inch which greatly reduced the time of plating test specimens. With high quality deposits and perfect adhesion the tests on these specimens resulted in a ductile fracture of the silver, leaving the bond intact. When the bond was weaker than the silver deposit, the separation came at the silver to nickel or silver to steel interface. It is not known how strong the bond can be because the silver fails before the maximum bond strength is reached.

Cleaning and Plating Cycle

The use of a nickel strike resulted in such high bond strength that it became necessary to give more attention to the preparation of the steel. It was found that with ordinary methods of cleaning and etching the bond would fail due to an actual separation between the surface layer of the steel and the natural crystalline steel metal. In order to remove this layer, and

also to provide a smoother base for the silver deposit, the surface was given an anodic sulfuric acid etch. The treatment eliminated the previous trouble, but introduced another. It was now found that occasionally the bond failed at the nickel to steel interface. It was thought that this might be due to passivity of the steel following the anodic etch. For this reason the steel was cleaned following the anodic etch, and then activated by dipping in hot muriatic acid. This procedure resulted in consistently perfect adhesion.

It will be noted that two silver strikes are used in this procedure. Under ideal conditions the second strike is unnecessary, as perfect results can be obtained without it. The extra strike was used as a safety factor in plant operation. When the thin deposit from the first strike is allowed to stand in air or in solution without current for a few seconds, it dissolves in the excess or free cyanide present. With rapid operation the work can be transferred from the strike to the plating bath before the silver strike plate dissolves. However, in actual plant operation it worked more satisfactorily to have the double strike.

The following cycle is used to obtain perfect adhesion of silver to steel:

1. Degrease in trichlorethylene vapors
2. Anodic clean in any good anodic steel cleaner or in the following solution:
   - Sodium carbonate (Na_2CO_3) 6 oz/gal
   - Sodium hydroxide (NaOH) 4 "
   - Tri-sodium phosphate (Na_3PO_4) 0.9 "
   - Tetra-sodium pyrophosphate ($Na_4P_2O_7$) 0.9 "
   - Temperature 180-200°F
   - Time 30 sec
   - Current density 100 asf
3. Rinse in warm water (120°F)
4. Anodic sulfuric acid etch:
   - Sulfuric acid (H_2SO_4) 18 N (50% by vol.)
   - Temperature 75°F
   - Time 20 sec
   - Potential 6 volt
   - Lead cathodes
5. Cold water rinse
6. Anodic clean as in step 2
7. Warm water rinse (120°F)
8. Muriatic acid dip:
   - Muriatic acid (HCl) 1.2 N (10% by vol.)
   - Temperature 180°F
   - Time 10 sec
9. Cold water rinse
10. Nickel strike:
    - Nickel chloride ($NiCl_2.6H_2O$) 32 oz/gal
    - Hydrochloric acid (HCl) 0.75 N
    - Temperature 75°F
    - Time 1-2 min
    - Current density 150 asf
    - Filtered constantly through activated carbon
    - Bagged nickel anodes
11. Cold water rinse
12. Silver strike No. 1:
    - Silver cyanide (AgCN) 0.133 oz/gal
    - Potassium cyanide (KCN) 6.0 "
    - Potassium carbonate 4.0 "
    - Temperature 75°F
    - Time 20 sec
    - Current density 30 asf
    - Filtered constantly through activated carbon
    - Steel anodes
13. Silver strike No. 2 (no rinse between strikes Nos. 1 and 2):
    - Silver cyanide (AgCN) 0.67 oz/gal
    - Potassium cyanide (KCN) 2.0 "
    - Potassium carbonate (K_2CO_3) 4.0 "
    - Temperature 75°F
    - Time 60 sec
    - Current density 4 asf
    - Filtered constantly through activated carbon
    - Steel anodes
14. Silver plate (no rinse between strike No. 2 and plating):
    - Silver cyanide (AgCN) 14.0 oz/gal
    - Potassium cyanide (KCN) 15.0 "
    - Potassium carbonate (K_2CO_3) 2-15 "
    - Potassium hydroxide (KOH), minimum 4.0 "
    - Brightener 0.02 cc/gal added every 15 min
    - Anti-pit agent — Hydrogen peroxide (H_2O_2) 0.2 cc/gal added every 30 min
    - Temperature 110-130°F
    - Current density 60-150 asf
    - Constant filtration through paper. No carbon or filter aids used
    - Strong agitation
    - Tank material glass

Heavy Silver Plating at High Rates of Deposition

The silver plating operation was performed in tempered glass tanks which had no protective shell around them. Glass was used as the tank material because laboratory tests showed it to provide cleaner and less contaminating operation than any other material. This was essential for producing high quality deposits without costly and time consuming purifications.

Of the various brighteners used an ammonium thiosulfate base material was most effective. In general, at a constant temperature, increasing amounts of brightener require higher current densities.

The three variables, brightener concentration, temperature, and current density are inseparably tied together. One cannot be changed without changing one or both of the others if the quality of deposits is to remain the same. The following instructions will show how they affect the deposits. With too much brightener, too low a current density, or too high a temperature, the edges of the work will be smooth and bright, but the center or recesses will be white and coarsely crystalline. Conversely, with too little brightener, too low a temperature, or too high a current density, the work will be smooth and bright in the center or recesses, and burned on the projections. The highest current densities may be used at high temperatures, but the broadest bright range is found at the low temperatures.

The bath was operated at 120°F for plating most work of simple shapes because high current densities could be used. However, when the work was of such shape that higher throwing power or a wider bright range were required, the temperature was reduced to 100°F or 110°F. This gave much better results, but required a lower current density.

Pitting

During the development work on the plating bath one of the most difficult problems to overcome was gas pitting. When it existed it could not be removed with batch or continuous treatment with activated carbon. Various wetting agents were tried, some of which temporarily alleviated the condition. However, with these the bath had a short life. Soon the deposits became beady and were unsatisfactory, and activated carbon purification would not remove this condition. Consequently the use of wetting agents was discontinued. Later it was found that the use of small additions of hydrogen peroxide would temporarily remove the pitting condition. It was a short step from there to the making of periodic additions of peroxide as a preventative. More or less can be used as conditions demand; enough is used to ensure freedom from pitting.

Cleanliness

In order to produce smooth plate the bath was kept as clean as possible. This was accomplished in three ways. First, the room was kept as clean as possible. It was sealed off from the rest of the plant by fastening all windows shut, installing airlock double doors, passing the inlet air through a precipitation unit to remove all suspended matter, and keeping the room under slight pressure at all times which prevented dirty air from being sucked in. Second, the bath was filtered constantly night and day at a rate of three times per hour through two filters in series. These units were constructed of stainless steel, and the filtering medium was a double thickness of paper. It was necessary to wet the paper before the filter was assembled to prevent breakage caused by contraction after the filter was set up. Third, was the problem of keeping the anode sludge out of the bath. This last was accomplished by separating the anode compartments from the plating compartment with multipore rubber diaphragms from U. S. Rubber Co. Located beneath the anodes was a suction manifold which fed the filter pumps. It produced a constant flow of solution from the plating compartment through the multipore diaphragm into the anode compartment, thence to the filter and finally back to the plating compartment. This system was very successful and kept the degree of nodulation at near zero.

Agitation

Agitation was produced by a separate pumping system which forced the bath past the work at a velocity of two to five feet per second. This was accomplished by using a large centrifugal pump connected to a double pipe manifold located on the bottom

and running the length of the tank. The pipes had small holes drilled from the top. The center lines of the pipes were 3 inches apart, and the holes were also 3 inches apart. This arrangement caused the solution to rise on either side of the rack of work which hung in the middle. In order to further increase the agitation and to average out the jet effect of the manifold holes, the cathode rod was moved a distance of 6 inches, 10 strokes per minute. The result was strong, smooth, uniform agitation which made possible the use of high current densities.

PROPERTIES OF THE DEPOSITS

Owing to the lack of published data on some of the physical characteristics of plated silver on steel, an investigation was undertaken to evaluate them. It was desired to learn the following:

1. Tensile strength variation with annealing in oxidizing and reducing atmospheres.
2. Hardness variation with annealing in oxidizing and reducing atmospheres.
3. Bond strength variation due to annealing in oxidizing and reducing atmospheres.
4. Effect of diffusing lead into copper.
5. Effect of annealing on fatigue strength.

These properties were studied and the results are given below:

Tensile Strength

It was found that with good quality bright silver deposits the tensile strength was about 48,000 psi. As they were annealed at higher and higher temperatures the tensile strength fell off. This effect was most pronounced below 400°F. Both oxidizing and reducing atmospheres were used for annealing the deposits. There was little difference between their effects at low temperatures, but at temperatures above 1200°F the silver annealed in air fell off in strength. The results are given in Table I and Fig. 1 and 2. The curves were quite normal, and were what would be expected for plated material except for the effect of air annealing at high temperatures.

Hardness

The hardness of the deposits was practically the same for both reducing and oxidizing atmospheres. Any difference between

TABLE I

EFFECT OF ANNEALING ON TENSILE STRENGTH OF ELECTRO-DEPOSITED SILVER

Annealing Time 1 Hour
Atmosphere as Indicated

Temperature	*Tensile Strength, psi*		
F°	*Air*	*Cracked Hydrogen Gas*	
As plated	48,000	48,000	48,000
400	25,800	.....	28,600
400	27,000	.....	27,600
800	26,300	23,000	24,400
800	23,750	23,100	24,200
900	25,100	23,150	25,800
900	25,000	23,300	25,800
1000	24,800	22,700	22,500
1000	21,500	22,600	22,600
1100	22,100	22,300	23,100
1100	22,800	19,950	23,500
1200	22,700	17,050	22,900
1200	22,750	19,800	20,400
1400	8,000	19,950	16,450
1400	9,200	18,300	16,650
1600	.....	20,600	19,050
1600	.....	20,200	19,750

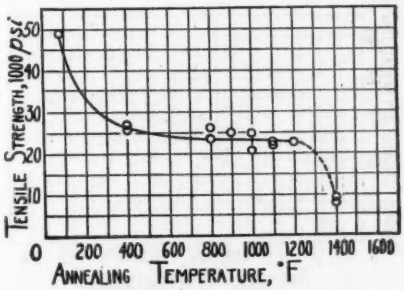

Fig. 1. Effect of Annealing in Air on Tensile Strength of Silver Deposit. Annealing Time 1 Hour.

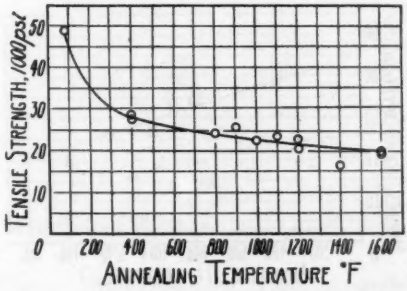

Fig. 2. Effect of Annealing in Hydrogen on Tensile Strength of Silver Deposit. Annealing Time 1 Hour.

TABLE II

EFFECT OF ANNEALING ON HARDNESS OF ELECTRODEPOSITED SILVER

Annealing Time 1 Hour
Atmosphere as Indicated

Temperature	*Hardness, Rockwell 15W*		
		Cracked Hydrogen	
°F	*Air*	*Gas*	
As plated	88	88	88
400	71.0	—	76.5
400	74.4	—	77.4
800	62.0	53.6	66.0
800	61.7	59.1	68.1
900	58.8	49.5	61.7
900	63.4	54.9	66.6
1000	60.5	49.0	53.6
1000	50.4	51.0	56.0
1100	55.4	44.8	55.5
1100	53.3	53.6	54.4
1200	45.8	41.7	52.6
1200	50.8	45.0	53.7
1400	42.5	38.5	38.6
1400	42.4	41.4	40.1
1600	—	39.4	40.0
1600	—	47.5	42.6

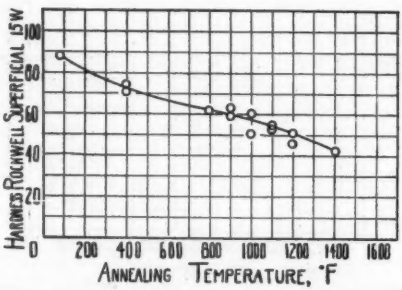

Fig. 3. Effect of Annealing in Air on Hardness of Silver Deposit. Annealing Time 1 Hour.

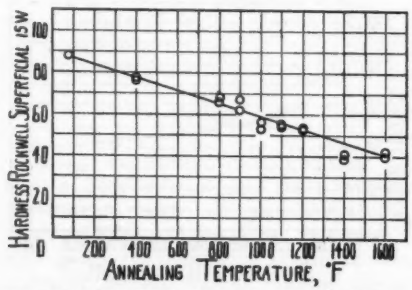

Fig. 4. Effect of Annealing in Hydrogen on Hardness of Silver Deposit. Annealing Time 1 Hour.

them fell within the limits of experimental error. The data obtained is found in Table II and Fig. 3 and 4. The curve is practically a straight line, showing a uniform falling off in hardness as the annealing temperature was raised.

Bond Strength

The bond strength comparison in Table III shows an interesting difference between annealing in the two atmospheres. The pieces annealed in the reducing atmos-

TABLE III

EFFECT OF ANNEALING ON ADHESION OF ELECTRODEPOSITED SILVER TO NICKEL STRUCK STEEL

Annealing Time 1 Hour
Atmosphere as Indicated

Types of failures indicated by superior figures

1 Ductile Tensile Fracture of Silver
2 Shear Failure of Silver
3 Crystalline Tensile Fracture of Silver
4 Crystalline fracture of Silver Adjacent to Steel
5 Bond separation

Temperature	*Stress on Bond Area, psi*		
°F	*Air*	*Cracked Gas*	*Hydrogen*
200	36,000[2]	.....	43,700[2]
200	52,600[1]	.....	31,720[2]
400	21,300[2]	.....	16,100[2]
400	29,000[2]	.....	29,750[2]
600	44,900[1]	.....	37,200[1]
600	36,700[2]	.....	29,600[2]
800	23,500[2]	30,300[2]	22,450[2]
800	41,200[3]	32,100[1]	35,400[1]
900	33,740[2]	22,000[2]	32,800[2]
900	35,200[4]	32,940[2]	32,500[2]
1000	42,000[3]	38,400[1]	22,100[2]
1000	26,500[4]	29,200[2]	16,260[2]
1100	18,150[4]	35,200[1]	32,800[2]
1100	18,740[5]	31,720[1]	22,000[2]
1200	.....[5]	26,700[2]	25,090[2]
1200	.....[5]	34,500[2]	28,400[1]
1300	.....[5]	30,250[2]	34,080[2]
1300	.....[5]	29,350[2]	32,400[2]
1400	9,500[4]	27,800[2]	17,480[2]
1400	13,000[4]	21,100[2]	31,550[2]
1600	14,880[5]	34,500[2]	17,100[2]
1600	28,400[3]	28,050[2]	24,100[2]

phere exhibit a bond strength greater than the strength of the silver even after annealing for an hour at 1600°F. No bond failures were found throughout the entire range of annealing temperatures. The silver fracture showed a ductile tensile separation. However, the samples annealed in air are quite different at 900°F and above. The bond strength falls off to zero in many cases, and the fracture occurred in a peculiar manner. The bond broke in such a way that the base metal was partially covered with crystalline silver. Photomicrographs show the reason for this. The air annealing permitted oxygen to diffuse into the deposits where it collected presumably as oxides near the bond. This interfered with the recrystallization and made for the discontinuous weak structure, shown in Fig. 5. X-ray diffraction studies confirmed the presence of oxides in the deposits. For this reason all bearings were diffused in a hydrogen atmosphere.

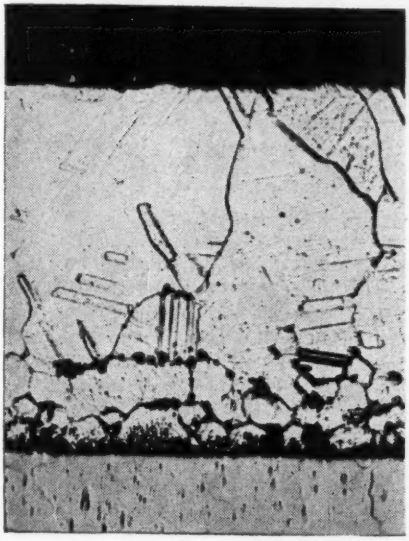

Fig. 5. Oxide Formation near Silver to Steel Interface after Annealing of Silver Plated Steel in Air at or above 900°F. Photo micrograph X150.

Diffusion of Lead

Other investigations were made to see if satisfactory bearings could be produced by diffusing a small amount of lead into the surface of a silver bearing. It was hoped that such a process would produce a bearing which would suffer less from chemical corrosion, erosion and seizure. Lead was deposited on the silver surfaces to various thicknesses between .00005 and .0005 inch. The samples were then annealed in hydrogen at various temperatures between 570° and 1100°F. The results are most interesting. They show that the lead penetrates along the grain boundaries of the silver to steel interface and accumulates there. The samples annealed at the higher temperature show no bond strength at all. Photomicrographs such as the one shown in Fig. 6 were made which prove the presence of lead at the interface. The results led to the question of whether or not bond failures found in bearings after use might be caused by lead diffusion. Consequently two bearings were examined. One had been operated for a long time with-

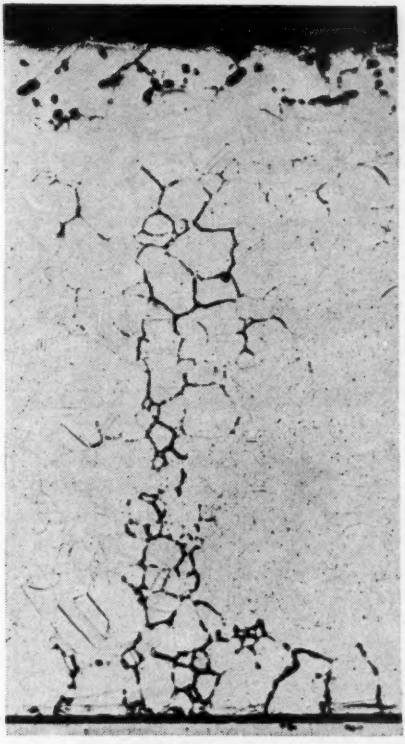

Fig. 6. Penetration of Lead in Grain Boundaries and along Silver to Steel Interface after Annealing of Silver Plated Steel with Lead Top Coating in Hydrogen at 1100°F. Photomicrograph X150.

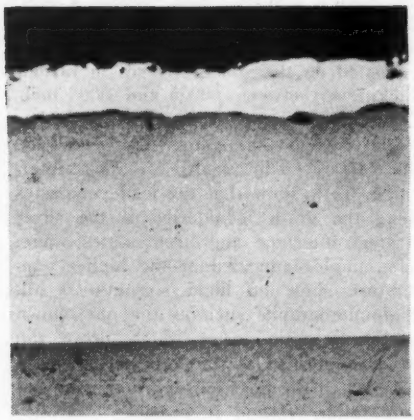

Fig. 7. Lead-Indium Coated Silver Bearing after Several Hundred Hours Operation without Failure. Light Area at Surface Is Lead. Microradiograph X150.

out failure, while the other had failed by "wiping". Microradiographs, Fig. 7, were made of the first bearing which show that the lead was diffusing into the silver, but it had not reached anywhere near the bond. There is no danger of a bond failure due to this amount of diffusion. The photomicrographs of the failed bearing in Fig. 8 and 9 show that some lead had penetrated to the silver-steel interface. It is not known whether the bond failed because of the lead or for other reasons, but it was shown that under conditions producing high temperatures in a bearing, lead will penetrate to the interface. Because of these findings no bearings were prepared for engine test with diffused lead on the surface.

Fatigue Resistance

The last property investigated was the fatigue resistance of silver plated bearings

Fig. 8. Penetration of Lead in Silver Grain Boundaries of Failed Lead-Indium Coated Silver Bearing. Photomicrograph X150.

Fig. 9. Penetration of Lead along Silver to Steel Interface of Failed Lead-Indium Coated Silver Bearing. Photomicrograph X150.

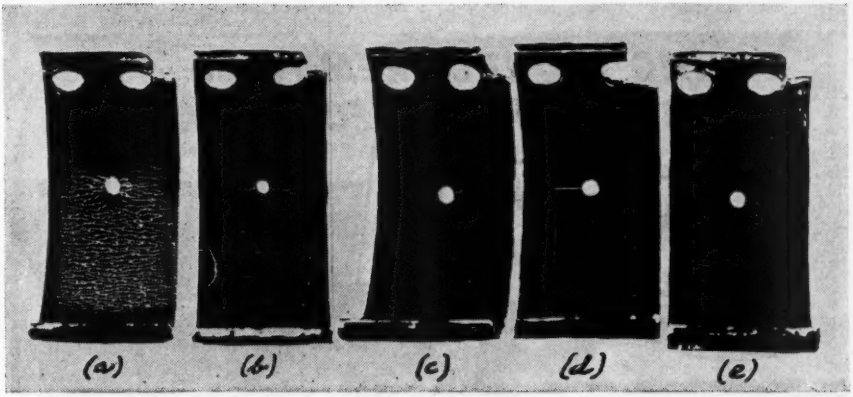

Fig. 10. Silver Plated Steel Bearing Shells after Fatigue Testing in Oil Bath of 300°F. Zyglo Pictures X1.5 reduced to X0.8.
(a) Silver Struck Specimen Heat Treated for 1 hr. at 1200°F. Deflection: 0.040 in for 4 hr., 0.050 in. for 4 hr.
(b) Nickel Struck Specimen Heat Treated for 1 hr. at 1000°F. Deflection: 0.050 in. for 4 hr.
(c) Silver Struck Specimen Heat Treated for 1 hr. at 1200°F. Deflection: 0.050 in. for 4 hr.
(d) Nickel Struck Specimen as Plated. Deflection: 0.050 in. for 10 hr.
(e) Silver Struck Specimen Heat Treated for 1 hr. at 1000°F. Deflection: 0.050 in. for 4 hr.

as affected by annealing. For this work steel automotive bearings were plated with .015 inch of silver and machined so that .010 inch remained. These shells were annealed through a range of temperatures and then fatigue tested by flexing the shell diametrically .010 inch in compression, allowing it to come back to the neutral position, and repeating. The test was carried out in an oil bath at 300°F. The results pictured in Fig. 10 show that the higher the annealing temperature, the lower is the fatigue resistance. There was considerable opposition to testing in operation a bearing which had not been annealed because of the possibility of breaking much expensive equipment, should it fail. However, one such bearing was plated and run in a test aircraft engine. The performance was excellent up to the time an oil line broke, causing the bearing to fail for lack of oil.

PLATING TO FINISH DIMENSIONS

One of the long range aims in this work was to plate bearings to finish dimensions, thus reducing the cost. This was accomplished in the laboratory, but was not attempted on a production basis. Certain bearings were plated to a thickness of .005 inch with perfect smoothness, and with sufficient accuracy to eliminate final machining. To do this special masks and shields were required, and sometimes special anodes. This is a challenging field wide open to the plating engineer.

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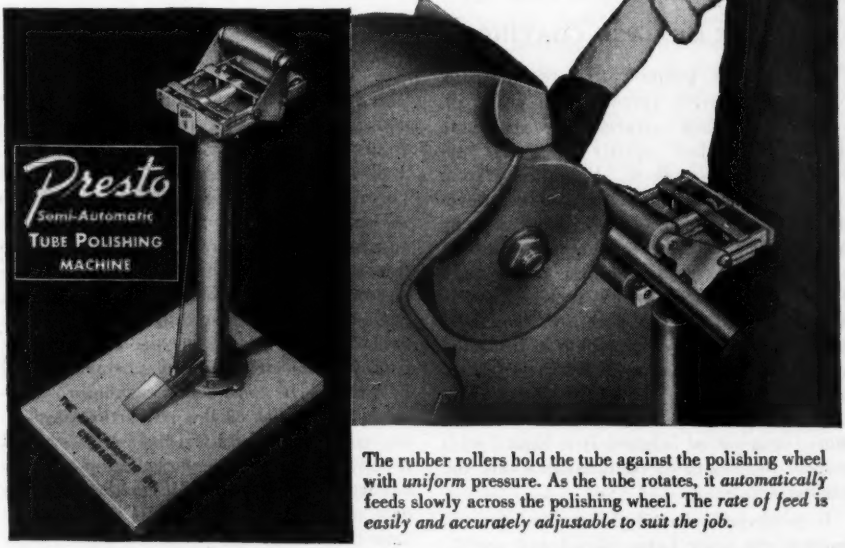

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PLATING RACK COATINGS

by L. A. CRITCHFIELD
District Manager
United Chromium, Inc.
Dayton, Ohio

PURPOSE OF RACK COATINGS

THE prime purpose of a rack coating is to prevent current from going directly to the rack surfaces. However, there are several other equally important advantages to be gained. Valuable plating metal is conserved both by avoiding needless plating onto the rack itself and by minimizing drag-out of metal-containing solution. It is surprising how much more solution is carried by a rack which is heavily plated to the point of roughness and treeing than by one which is insulated and free from roughness. With the costly high concentration baths of today, this solution loss can be important. Furthermore, drag-out of solution is a hazard with respect to drag-in of contaminants into the plating solutions.

It is obvious that if the current is confined to the work being plated and not diverted to bare rack members it is easier to cover recessed articles. Many times this factor has made it possible to achieve coverage otherwise impossible or to permit the use of a rack of simple design instead of a composite rack.

Conservation of current by rack insulation is important from several standpoints. It is not unusual for uncoated racks, particularly after roughness has developed, to consume a third or more of the current. The power to generate this wasted current costs just as much per kilowatt-hour as the power doing useful work. Where current capacity governs output, production may be increased appreciably by the substitution of coated for uncoated racks. The higher current densities or more pieces per tank possible when every ampere is put to work, means more production.

A further saving which results from the use of rack coating may be lowered rack maintenance expense. Minor repairs are certainly less costly than replacement of complete racks.

REQUIREMENTS OF A RACK COATING

A most important requirement of a rack coating is chemical inertness, since this is necessary for long life and good service. Plating cycles make use of many types of chemicals, from concentrated acids to strong alkalies and from reducing agents to powerful oxidizers. It is not very difficult to specify a material which will resist only muriatic acid, or sulphuric acid, or caustic soda, or the cyanides, or chromic acid, or nickel salts, or any one or some combinations of the many chemicals used by platers. It does, however, require thorough knowledge of the properties of coating components and skillful selection and integration of such components to design a coating resistant to all of these chemicals under actual conditions of use with cathodic and anodic potentials and at high and low temperatures. Even resistance to water must be considered since, if a coating absorbs water to any extent, its electrical resistance drops and trouble starts.

The inertness of the coating to chemical action must also be considered with respect to contamination of the plating solutions. Most plating baths are sensitive to impurities. Hence, it is of no little importance that rack coatings be designed to avoid possible contamination from the coating itself. Resins, solvents, plasticizers, and other coating components must all be examined critically in this respect.

While chemical resistance is a very important requirement, it is not sufficient by itself. The physical properties of the coating also require consideration. The coating must be tough and strong. A tough, wear resistant coating is required to withstand even the normal mechanical abuse to which most racks are subjected. The coating must be flexible and remain so in order to stand up on spring contacts. In passing from boiling cleaners into cold

rinses and from cold solutions into hot, plating racks encounter temperature changes of as much as 150°F. Hence the coating must also possess resistance to thermal shock. Naturally, a rack coating must be a good electrical insulator, and it must retain this property under the conditions of service throughout its life.

A very important consideration in the design of a rack coating is the method of application and repair. The coating material must be such that it can be applied readily by the user, and must lend itself to easy repair, should the coating become damaged.

TYPES OF RACK COATINGS

Plastic Tapes

Plastic tapes are very convenient for the insulation of racks of simple design and can be made of materials which have high chemical resistance. Tapes are difficult to apply to racks having multiple cross arms, without the formation of air pockets which develop into blisters when the rack is placed in hot solutions.

Plastic tapes have the virtue of quick application. When the proper technique of application is carefully used, they give excellent service. Most tapes give improved results when they are subsequently coated with a properly formulated liquid sealer. It is usually applied by brushing, but dipping is used also. The sealer acts as a cement and may, by partly dissolving the tape, cause it to become a heavy homogeneous coating.

Waxes

Hot dipping in wax-like materials provides an excellent coating for temporary racks. Materials of this sort are available with melting points far above the temperatures encountered in any plating cycle, and hence the coated racks may be sent through hot alkaline cleaners without harm to the coating. The chemical resistance of some of these materials is excellent, a few being completely resistant to all solutions used by the plater. Some others stand up well enough for temporary use but introduce the danger of solution contamination.

Waxes also have the advantage of very quick application. The coating may be built up to any desired thickness by repeated dipping. The contact points are readily bared by trimming or by the use of masking tape.

The physical properties of most waxes leave something to be desired. Wax coated racks must be handled carefully to prevent damage to the coating. A hard wax is apt to crack and peel, and a highly plasticized wax is too easily marred. If, however, the coating is damaged it generally can be repaired quickly and easily.

The wax compounds are best melted in electrically heated, thermostatically controlled melting pots. Gas fired pots should not be used because of the fire and explosion hazard. Where the plating cycle is such that high temperatures are not encountered, low melting point waxes are available which can be melted in water jacketed pots.

Ventilation of the wax melting pot is recommended. Some waxes are toxic and ventilation must be used to save workers from breathing the fumes (a bad thing with any wax), and to prevent condensation of the fumes on the skin, a possible source of dermatitis.

Rubber Coating

Rubber covered racks have been in use for many years and were among the first coated racks. They have given quite satisfactory service in some plating cycles.

The rubber covering is generally applied either by cementing rubber sheeting to the rack members, or by anaphoresis, the anode process whereby the rubber is electrochemically deposited onto the rack from a latex solution. In either case the rubber is usually vulcanized.

Entirely aside from the fact that special equipment, not generally available to the plating shop, is required to apply rubber coverings, its more extended use has been handicapped by lack of sufficient chemical resistance. Elevated solution temperatures or highly oxidizing chemicals such as chromium plating solutions, cause rapid deterioration of rubber. The result is objectionable contamination of the bath, shortened coating life, loss of insulating properties, heavy carry over of solutions, and generally unsatisfactory performance.

From the standpoint of resistance to mechanical abuse, rubber covered racks have given excellent service. However, when repairs are necessary through accidental damage, complete recoating is probably the most economical treatment.

Synthetic Resin Coatings

Coatings made from synthetic resins dissolved in proper solvents are probably the most popular type of permanent rack coatings. Hence they deserve to be treated in considerable detail and their application and use fully considered.

Synthetic resin materials can be formulated to meet the requirements of good rack coatings as previously indicated. Two types are used. One is an "envelope" type designed to form a film which shrinks upon air drying to form a tight sheath about the rack members. The other is an "adherent" type which clings tenaciously to the surface upon which it is applied. Both of these types can be formulated to give coatings which are tough, resilient, and flexible so that they will withstand handling and mechanical abuse, and which at the same time are resistant to plating chemicals without solution contamination.

The envelope type coating has been used very successfully in many plating cycles but does not give as good results as the adherent type when taken through severe plating cycles and on aluminum anodizing racks. The adherent type usually is at its best when force dried, for which only moderate temperatures are necessary.

The synthetic resin coatings have the advantage of ease of application and maintenance. They can be applied in the user's own plant without special equipment; they can be easily trimmed to bare the contacts; they can be readily patched in event of damage or change of rack design; and they can be readily removed when recoating is desirable or major repairs must be made.

Synthetic resin coatings are applied by dipping, spraying or brushing. Dipping has proved to be most satisfactory to the many users of this kind of rack coating. A suitable thickness of film can be conveniently built up with the least number of operations. A minimum amount of equipment is required, because the material can be supplied in open-end drums, which are suitable for use as dipping containers. If a special dip tank is desired, it can be easily fabricated to required dimensions. The dipping tank should be made of terne plate if obtainable, or of black iron. Galvanized sheet should not be used because the zinc may cause jelling of the coating material.

Spraying should not be considered for most racks, because the small cross-sectional dimensions result in wasteful overspray with an unavoidable loss of much of the coating material. Also, since it is necessary to add a large percentage of thinner to reduce the coating to spraying viscosity, only a very thin film is produced and it is necessary to spray many times to build up sufficient coating thickness. Hence, the time and labor required usually exceeds that for dipping. Sometimes, for heavy racks having large surfaces or cumbersome shapes, spraying may be necessary.

Brushing, too, is generally to be avoided, because the coating materials do not flow very well. Also, in applying multiple coats, each fresh coat tends to soften the preceding coat to such an extent that brushing is doubly difficult, and brush marks, air bubbles, and thin spots, especially on edges, are almost impossible to avoid. These all diminish the service life of the coating.

COATING TECHNIQUE

Preparatory Steps

Before being coated, the racks should be carefully cleaned and thoroughly pickled to remove all fire scale. Sandblasting should be used when available as this will give distinctly improved adhesion. Many users like to copper plate their racks after cleaning. Aluminum racks should always be anodized before coating. All racks must be completely dried before being coated.

Before the coating material is used, it should be thoroughly stirred with a broad-blade wood or metal paddle to insure uniform consistency and then checked for viscosity. If thinner is required, it should be added in small quantities and well mixed in after each addition. After stirring, the coating material should stand with the container cover in place for at least an hour, and longer if possible, to allow complete release of all air bubbles.

Determination of Viscosity

For uniform results, a viscosimeter should be used in adjusting the consistency of the material. The Zahn Cup is a convenient instrument for this purpose. It consists of a bullet shaped metal cup of definite capacity with a calibrated orifice in the bottom through which the material can drain. Various orifice sizes are used depend-

ing on the material to be tested. The No. 4 Zahn Cup is best suited for use with rack coating materials.

The viscosity test is carried out simply by lifting out a cupful of the material and determination of the number of seconds required for the contents to drain through the hole. The point at which the draining thread of material first breaks is taken as the end-point of the test. In practice, the cup is allowed to hang in the material between tests. This makes it readily available for checking the material at any time and avoids the necessity for cleaning the cup before each time it is used.

Dipping Procedure

When the racks are being dipped into the coating material, they should be tipped at various angles so that each member enter the liquid at an angle rather than with a horizontal surface. Before it is withdrawn, the rack should be shaken back and forth to remove any air bubbles which cling to it. In applying the first coat many operators let the rack hang in the resin solution for a period of time, as long as an hour, to permit the coating to penetrate any crevices and release all air. This, of course, can not be done when subsequent coats are applied, since the preceding coats would tend to redissolve.

The rate of dipping will depend to a large extent on the design of the rack but should be consistent with conditions. If the dipping is too rapid a large number of air bubbles are formed. If the dipping is too slow, some of the previously applied coating may redissolve, resulting in thin coatings, especially on edges. Care should always be taken to avoid having air bubbles floating on top of the liquid. Such bubbles will dissipate if the dipping container is covered for ten or fifteen minutes.

The rate and manner of withdrawal from the coating material is also governed to a considerable extent by the rack design and should be such as to give effective drainage of the coating. Tipping the rack from side to side as it is being withdrawn from the tank usually assists the drainage, Fig. 1. A still more uniform coating with a minimum of drippage or tears is obtained if the rack is inverted and turned several times after it has been withdrawn from the dipping tank. This operation permits

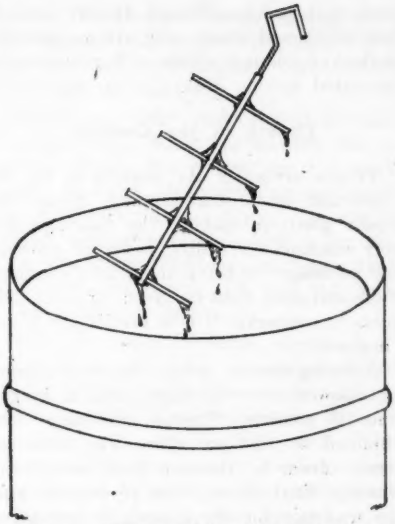


Fig. 1. Rack position for draining.

partial setting of the coating with more uniform distribution.

In some cases, webs are formed between parts of the rack on withdrawal. If a web is not attended to, it will thin out like a soap bubble until it breaks with a snap, producing innumerable tiny air bubbles in the adjacent wet coating. If the withdrawal of the rack is stopped for a few seconds when the webs first appear at the solution level, they will break while they are small and thick so that no air bubbles are formed. Webs which do not break of their own accord at this stage can be broken by blowing onto them with the breath or by piercing them with a wire or pointed stick. In cases where a complete web, one or two inches high, forms between parts which are open at the bottom, best results are obtained by withdrawing the rack more rapidly at this point, so that he heavy liquid at the open bottom pulls off the web before it has time to thin out and snap.

Number of Coats

The number of coats to be applied is largely determined by the plating cycle involved and the results expected. For aluminum anodizing cycles and severe plating cycles, a minimum of eight coats is usually recommended. When racks are constructed of round stock and dipping is done under ideal conditions, as few as four

coats may prove sufficient. In any case, a few additional coats will always provide a thicker coating which will give greatly increased service life.

Drying of the Coating

Proper drying of the coating is just as important as proper dipping. Since the resins used in making the coatings are very inactive chemically, powerful solvents are necessary to bring them into solution. Sufficient time must be given for these solvents to evaporate if best results are to be obtained.

A drying time of at least one hour should be allowed between coats, and a longer time if possible. Several advantages are obtained by this procedure. For instance, more solvent is liberated from each coat, whereby final drying time is reduced and the tendency for the coating to redissolve during subsequent dipping lessened. The final coat should be dried as long as possible, and never less than six hours. If the rack dipping is started at the beginning of the day, the required number of coats can be applied at hourly intervals during the day, permitting the final coat to be dried overnight. When it can be arranged conveniently, the life of the rack can be extended appreciably by allowing the coating to dry still longer, even for several days to a week, before the rack is used.

Force-drying of the coating should be done according to the manufacturer's recommendations. Usually, only the first and last coats are force-dried. This gives a very adherent coating with a tough shell and a resilient core which make it particularly resistant to mechanical damage.

The drying oven must be of such a design that the inflammable vapors can not come into contact with an open flame. Since temperatures over 200°F are seldom necessary, an insulated box of suitable size containing a steam coil makes a convenient oven. The oven should be vented to the outside air, and forced air circulation by means of a fan should be considered.

The rack coating department should be carefully planned. The room should have adequate area and should be well ventilated, have clean air and be of even temperature; and it should be furnished with suitable frames on which to hang the racks during the coating process.

Baring of Contacts

Trimming or baring of contacts should be done carefully. The coating should be cut through completely with a sharp knife before it is removed. Any semblance of tearing of the coating must be avoided, since it will loosen the adjacent coating and provide a pocket which will trap solutions and likely cause premature failure.

Masking tape may be used to advantage on areas which are to be subsequently bared. Before the tape is removed, however, the coating should be cut cleanly at the edge of the tape so that no tearing takes place.

It is excellent practice always to seal cut edges by flowing a single coat of material around the cut with a small brush as shown in Fig. 2. This will effectively minimize any tendency for solution to creep under the coating.

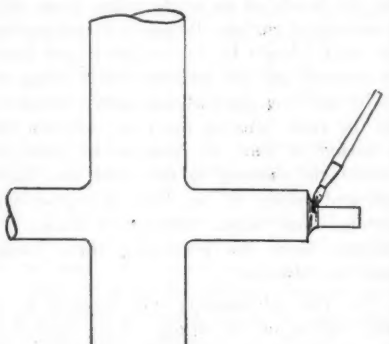


Fig. 2. Sealing at bared contacts.

Where force-drying is practiced, trimming and sealing should always be done before the final force-drying operation. Trimming after force-drying is difficult.

Repairs and Alterations

As already indicated, an advantage of some synthetic resin coatings is that rack contacts may be altered or repaired without the necessity of the redipping of the entire rack. Areas bared by mechanical damage can be patched.

Any loose coating should be cut away with a sharp knife to prevent further tear-

ing and loosening. Projecting nodules of electrodeposits should be broken off or otherwise removed. The rack should then be soaked in water to cause any plating salts present to dissolve, rinsed well, and thoroughly dried. The coating material is flowed onto the bare spots with a brush, and the patch permitted to dry for an hour. Additional coats should be similarly applied to the damaged area every hour until the thickness has been brought back to its original value. The rack should then be air-dried at room temperature for 48 hours or, after preliminary air-drying at room temperature for two hours, it may be force-dried as described earlier. In extreme cases, it may be advantageous to re-dip the entire rack once or twice after the patching has been completed.

When major repairs or alterations to a rack are required it is sometimes best to remove the coating entirely from the rack, and recoat after the repairs or alterations have been completed. While some operators prefer to slit the coating and remove it by peeling, removal may be accomplished with greater ease by suspending the rack overnight in a covered container with coating thinner or "remover". This should dissolve the coating entirely and cleanly, with a minimum of labor and without damage to the rack. It is poor practice to attempt to reuse the dissolved coating because it is probably contaminated with plating salts and metal particles which may lead to inferior results; and it might also ruin fresh material to which it is added.

Any trees or rough spots should be removed by filing or grinding. The rack is then ready for re-coating by the normal ruin fresh material to which it is added.

RACK DESIGN

There are a number of important factors which should be taken into account when racks are being designed, manufactured, coated or used. Properly considered, they can add very appreciably to the life of the racks and the rack coatings.

Aside from proper rack design as to number, spacing and position of the parts to be plated, it is necessary that each of the rack members have sufficient cross-sectional area to carry the required amount of current without undue heating. Too light a construction besides having other disadvantages, will cause overheating which may result in a temperature high enough to damage the coating.

Whenever possible racks should be made of round stock. When flat sections are required, round edge or oval section stock should be used. If square cornered stock must be employed, the sharp edge should be broken with a file. The slight effort expended will pay dividends in longer rack life since any coating will pull thin over a sharp edge or corner.

When the racks are being assembled, all joints should be brazed or as a second choice, soldered. This is important, not only electrically for better contact between members and mechanically for added strength, but also from a coating standpoint for the elimination of air entrapment.

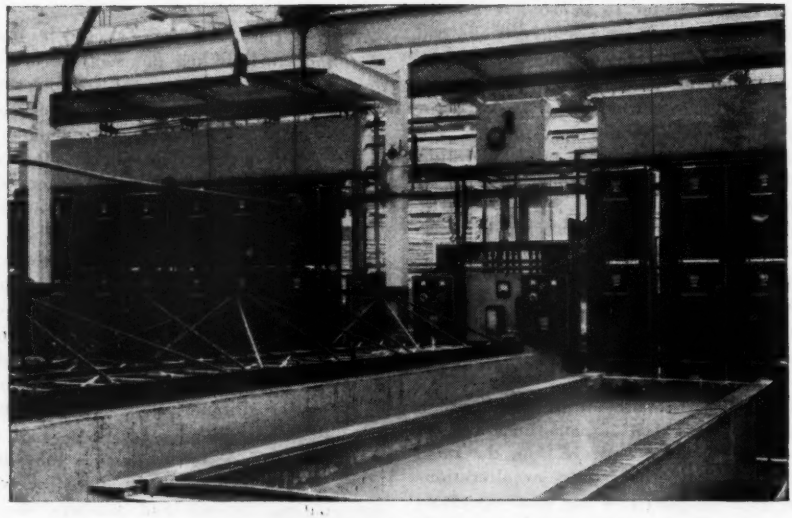
By the same token, care should be used throughout the design to exclude the possibility of air pockets which interfere with the coating. Screws and washers should be avoided whenever possible as they are especially difficult to coat without the formation of air bubbles in the coating.

IMPORTANT PRECAUTIONS

Certain precautions should always be observed in the handling of rack coating materials. When shipped during cold weather or stored in cold rooms, they may form soft, semi-solid gels. Very gradual return to the normal liquid state does occur when the temperature of the material rises to 70°F to 90°F, but this process is slow because of the low heat conductivity of the material. The restoration can be accelerated by allowing the container to stand in warm water of about 110°F and by occasional stirring of the material until any remaining gel is completely liquified. Thinner should *not* be used for the purpose of dissolving the gel as this would result in too thin a coating being applied when the temperature becomes normal. Gel formation can largely be avoided by storage of supplies in a warm place.

The material container should be provided with a tight fitting lid, kept in place at all times when the material is not in use. This will prevent unwarranted evaporation of solvents and greatly reduce thin-

(*Continued on page* 191)



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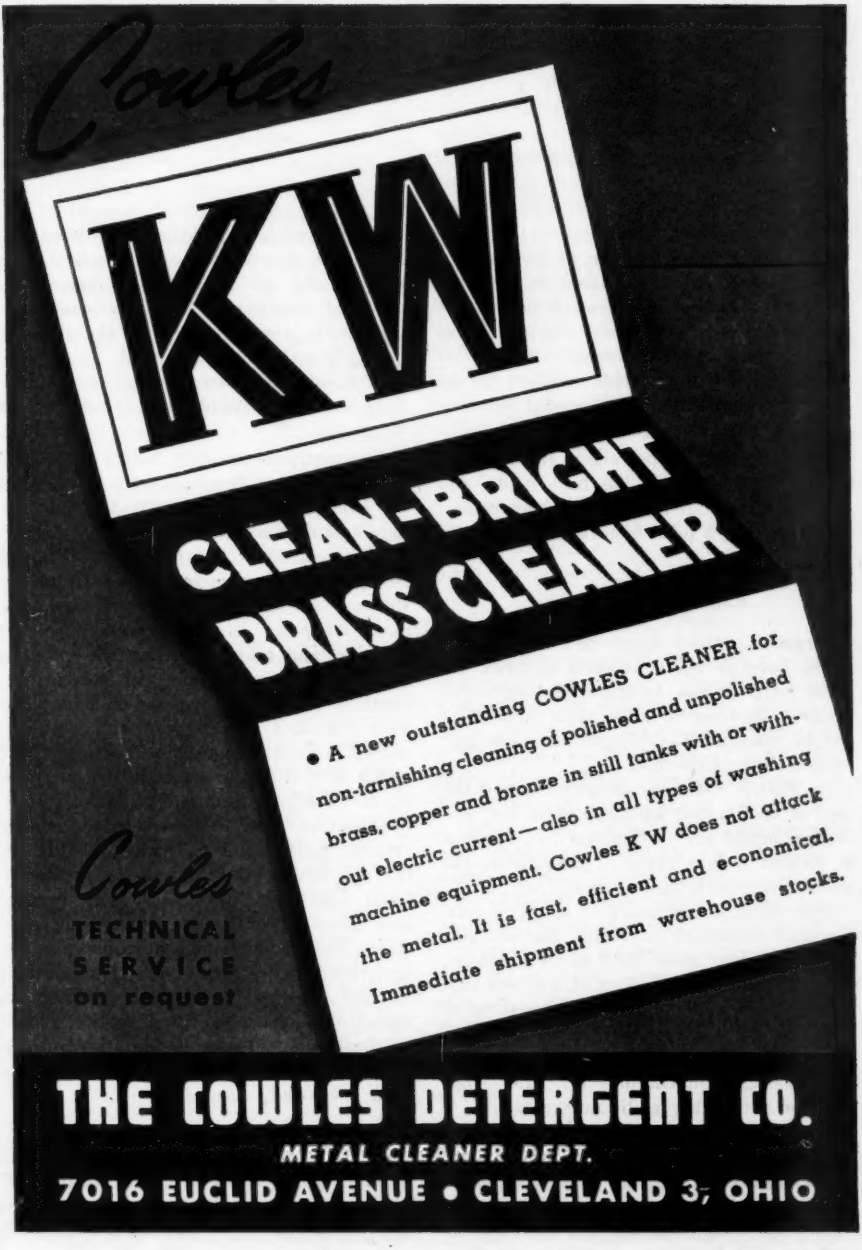
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Bright Nickel Plating

A Review Of Progress

by

R. B. SALTONSTALL

The Udylite Corporation, Detroit, Mich.

BRIGHT nickel plating, sharply curtailed during the war, is once more a subject of immediate importance. The development and improvement of proprietary processes over the past ten year have brought bright nickel plating to its present acceptance by the plating industry as an economic necessity for successful competition in the field of decorative plating.

It is, therefore, opportune to review briefly the progress which has been made, and to point out needs for further improvement. In doing this, a brief historical sketch is in order.

EARLY HISTORY

Organic addition agents to nickel plating baths were proposed as early as 1890, but their purpose was to allow plating to increased thicknesses rather than to produce bright coatings. They functioned principally as buffer compounds.

In 1905, a German patent described the use of an organic addition agent for producing bright nickel deposits but, because it yielded only a trace of brightness, the process met with little success.

The effect of cadmium in small quantities as a brightener in nickel solutions was first recognized about 1912 in Birmingham, England. The similar effect of zinc was discovered somewhat later. It is interesting to note that these metals are still used for this purpose, either alone for barrel and still tank plating thin coatings for mild exposure, or with other addition agents.

When cadmium or zinc are used alone, the deposits tend to be quite brittle, and the thickness of deposit is limited to about 0.0003 inch. Some organic addition agents, when used with cadmium and zinc, act to overcome this brittleness and make possible the deposition of heavier deposits having more desirable mechanical properties.

Among early addition agents were colloids such as gum tragacanth, gum arabic, glucose and glue. They give varying degrees of brightness, but their concentrations were very critical and the deposits generally brittle and unsound.

The limitations described above naturally restricted the applications of bright nickel plating.

The first process which led to a commercially important development is the Schlotter process, patented in 1932. It is not the object of this article to give details regarding the chemical compositions of nickel baths or addition agents. Suffice it to say that modern bright nickel baths are in the main composed of nickel sulfate, nickel chloride, and boric acid, and one or more addition agents which act either as brighteners or anti-pitting agents or both. The bath described in the Schlotter patent employed a type of organic addition agent which is still in use today in one or more of the modern proprietary baths. While this was not the first bath which would produce bright deposits, it was probably the first one which would permit the plating of fairly heavy bright coatings with reasonably good physical and mechanical properties. Plating on buffed surfaces gave the best results. The "rate of brightening", i.e., increase in brightness with increasing thickness, was quite small. However, the Schlotter bath pointed the possibilities in the field, and several superior baths have since been developed.

DESIRED PROPERTIES

Before going further, let us list the desired properties of both the ideal bright nickel bath and the deposit. This was well done by Eckelmann in 1934, as follows:

"*The Electrolyte* (1) must be stable on continued and extensive use, (2) must have

a wide operating range as to pH, concentration, temperature and other variables, (3) must possess high anode and cathode efficiencies, (4) should produce a bright plate of maximum brilliance at as high current densities as possible, (5) must have high throwing power, (6) should be least sensitive to contaminants, both organic and inorganic, (7) must be simple to control, and (8) should be readily adaptable to corrective and purification methods.

"*The Deposit* (1) must possess maximum brilliance irrespective of thickness, (2) must have minimum porosity, (3) must have maximum adhesion, (4) must afford high protective value against corrosion, (5) must be uniform, dense and ductile, (6) should increase the throwing power of any chromium deposit subsequently applied to it, (7) should not be critical as to hydrogen absorption, and (8) should be free from nickel hydrate in the crystal grid."

This sounds like a large order. Let us examine some of these requisites individually and note to what extent they have been met in the past ten years.

REQUIREMENTS OF THE SOLUTION

Stability of Electrolyte

This requirement has been well met by most, if not all the modern proprietary bright nickel baths. The fact that some are known to have operated satisfactorily for as long as six months with no purification or filtration (against the advice of the supplier) is adequate proof of this.

Operating Range

This characteristic varies considerably among the different processes, but in general considerable progress has been made. Most existing shortcomings can be ameliorated by reasonable control of variables.

Efficiency

High efficiency is characteristic of the base of most bright nickel baths, the Watts type nickel bath. Within a pH range between 3.0 and 6.0, the cathode efficiency is above 95% and the anode efficiency usually higher. An addition agent which lowers appreciably either anode or cathode efficiency is undesirable.

Bright Plate Current Density Range

A wide bright plate range has been one of the more difficult ends to attain. Since it is possible to increase the limiting current density of a white nickel solution by increasing the nickel and chloride contents, this in itself presented no problem within reasonable limits. To develop addition agents which would give a bright deposit at all current densities within the range of the primary nickel solution was a much more difficult problem. It has been met in varying degrees with various combinations of addition agents. Some of the earlier baths had a rather narrow current density range for bright plate; clouds, dullness, or deposits of unsatisfactory physical properties appearing in recesses and high current density areas. While new addition agents have improved this condition considerably, this is one property which might well be further improved. Impurities, to be discussed later, may also have an adverse effect on the current density and temperature ranges within which bright plate may be obtained.

Throwing Power

This property and its close relative "covering power" are closely related to the preceding one and are of extreme importance. Many addition agents have been tried which will produce excellent deposits on flat surfaces, but completely prevent deposition on deeply recessed areas. The throwing power of acid nickel solutions is fundamentally poor when compared with that of alkaline, nickel, copper, zinc, cadmium, tin, etc., and addition agents which injure these properties should be studiously avoided.

Many organic compounds, such as certain rubber accelerators and organic sulfides and some inorganic materials, when present in very small quantities as contaminants, have a large undesirable effect on these properties. This brings us to the subject of

Sensitivity to Contaminants

All plating solutions operated in production are subject to contamination. The sources of contamination are legion, a few of the more important ones being:

Buffing dirt and dust from the air; rack coatings (improperly chosen); tank

linings (improperly chosen); impure chemicals.

Attack of solution on work (copper, zinc); grease and oil from air and equipment; decomposition products of unstable addition agents.

Drag-in of other solutions on work not thoroughly rinsed, with shapes which tend to pocket solution, and in broken blisters or pockets on rack insulation; dirt on work not thoroughly cleaned.

Fortunately, procedures such as electrolytic purification (plating on scrap cathodes at low current density), filtration with activated carbon, chemical oxidation, etc., have been proved effective in the removal of practically all ordinary contaminants. The perfect method of avoiding troubles caused by contamination is, of course, to prevent it. This, however, can seldom be completely realized in practice; hence it is important that the solution be as insensitive as possible to the more usual contaminants. For example, some combinations of addition agents make the bath much more sensitive to zinc and copper than others. This is a very important factor in the choice of a bath for plating on zinc base diecastings, but is of little consequence if steel parts are to be plated.

Simplicity of Control

This is a highly desirable requisite for any process for obvious reasons. The concentration of most of the addition agents used in modern bright nickel solutions can be determined analytically. The problem has been to develop analytical methods combining required accuracy with simplicity, and it has been quite satisfactorily solved in most cases.

REQUIREMENTS OF THE DEPOSIT

Maximum Brilliance Irrespective of Thickness

This objective is not difficult to reach on highly polished or buffed base metal, but there seems to be little probability of meeting this requirement on poorly polished or rough surfaces. Bright nickel processes are available which have a high "rate of brightening", by which is meant that as the deposit becomes thicker, minor surface defects are smoothed out. Two methods have been applied to the measurement of this property. One is to observe the difference in the clarity of the reflection from a given quality of surface after plating with thin and heavy deposits of bright nickel. The other method consists in measuring the surface profile by a delicate instrument called the "Surface Analyzer" in which a delicately balanced point is moved slowly over the metal surface, magnifying the irregularities with an electronic device and recording the magnified irregularities on a moving tape.

Post-war specifications for copper-nickel coatings on steel for severe exposure call for coatings of each of from two to three times the thicknesses formerly specified. If the bright nickel coating is applied over buffed copper or bright copper this will simplify the "rate of brightening" problem as far as the bright nickel is concerned. Undoubtedly emphasis on brightness will continue undiminished, but increased emphasis is anticipated on other properties to be discussed below.

Maximum Adhesion

Bright nickel is admittedly more sensitive to poor cleaning than white nickel or metals plated from alkaline solutions. The improvements in metal cleaning caused directly by the advent of bright nickel might be compared to the improvement in nickel plating caused by the advent of chromium plating. So before condemning any bright nickel plating process because of faulty adhesion of deposit, one should make sure that the preparation of the surface for plating is beyond reproach.

The presence of impurities in the bright nickel solution is probably the next most usual cause of poor adhesion. The author has seen many pilot tests made on bright nickel solution samples in which a simple treatment with activated carbon made the difference between very poor and excellent adhesion, the cleaning of the base metal being as nearly equal as possible in both cases.

Large excesses of certain addition agents and poor balance of inorganic constituents of the solution may also have an effect.

Good adhesion is not the only reason for better cleaning for bright nickel. Many thin films or stains interfere with the de-

position of a bright deposit. Visually, it appears that the stain "shows through" the deposit, especially if it is 0.0005 inch thick or less, as is frequently the case on buffed brass or copper. The undesirable appearance of such defects may not be the most serious result. Porosity may be created, and buffing such defective areas to help appearance may result in thin spots.

Minimum Porosity, Ductility and Resistance to Corrosion

These factors are so closely connected that they will be discussed together.

Porosity of white nickel deposits has been the subject of considerable research. It is recognized that the nature and preparation of the base metal surface and freedom of the solution from suspended particles are both important factors. These are, to say the least, equally important in bright nickel plating. Porosity is one of the principal causes of failure of bright nickel coatings. One method of decreasing porosity caused by base metal defects is to copper plate, copper buff and bright nickel plate. Since porosity tends to decrease as thickness of deposit increases, heavy coatings are superior to thin ones on the same surface.

Auxiliary tanks and filters for batch filtration and purification, as well as arrangements for continuous filtration are strongly recommended for efficient, economical operation.

Stability of addition agents is an important factor in this connection. If an addition agent decomposes to form solid insoluble particles or oily liquids which are immiscible with the plating solution, porosity is a natural result.

Ductility of deposit is another important factor which may have a definite effect on corrosion resistance. This is especially true if the plated article is subject to flexing or deformation in use. Even in the case of castings, temperature changes may alter the size of the casting enough to cause cracking of a brittle, highly stressed nickel deposit and subsequent corrosion through the cracks.

Generally speaking, bright nickel deposits are not as ductile as white nickel deposits from pure Watts type solutions. However, a great deal of progress has been made in this respect, and a satisfactory degree of ductility is obtainable by correct choice of addition agents and by keeping the solution free from impurities.

The inherent resistance of the deposited nickel itself to chemical attack may vary considerably. The best bright nickel coatings may be attacked a little more rapidly by certain chemical reagents than pure white nickel deposits. Wide variations in rate of attack are possible, depending on the addition agents used.

Coverage with Chromium

Unbuffed bright nickel deposits with few exceptions will take a chromium deposit at a lower current density than buffed or unbuffed white nickel. The reasons for this are not definitely known, but it gives bright nickel a definite advantage.

ADVANTAGES OF BRIGHT NICKEL

In conclusion, some of the advantages of modern bright nickel over white nickel are:

1. Savings in cost of nickel buffing
2. Bright plate is had in recesses and on complicated shapes, impractical to buff.
3. Elimination of cut-throughs and thin sections caused by buffing
4. Savings in time and nickel deposited, because none is removed by buffing
5. Elimination of reracking prior to chromium plating
6. Improved coverage with chromium.

Bright nickel should not be thought of as a panacea for all finishing problems. It is a tool, the development of which has advanced it to a practical stage, which will undoubtedly find many new applications in the post-war era.

Klem Kleaners Bulletin

A new eight-page bulletin describes this line of products for use in metal finishing including items for rust removal, metal cleaning, surface preparation, soldering and pickling. The products, their advantages and methods of use are well detailed.

Write for Klem Kleaners Bulletin MR, Klem Chemical Works, 14401 Lanson Avenue, Dearborn, Mich.

THE ADHESION OF ELECTRODEPOSITS

IV. CORRELATED ABSTRACT OF COMMENTS ON METHODS FOR MEASURING THE DEGREE OF ADHESION

A. E. S. Research Project No. 3

Project Director: A. L. Ferguson

Chemistry Department, University of Michigan
Ann Arbor, Michigan

Outline of Paper

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This is the fourth in a series of reports. The first report, *Bibliography*, was published in MONTHLY REVIEW **32**, 894 (1945); the second, *General Considerations*, in MONTHLY REVIEW **32**, 1006 (1945); and the third, *Correlated Abstract of Published Methods for Measuring the Degree of Adhesion*, in MONTHLY REVIEW **32**, 1116, 1237 (1945) and **33**, 45 (1946).

Introduction

THE previous report was a summary and critical analysis of information contained in the literature. The present report is a summary of information contained in communications resulting from a circular letter sent to the total membership of the American Electroplaters' Society, and from many personal letters sent to outstanding men in electroplating and related fields, requesting that they submit their personal experiences in the use of methods for measuring the adhesion of electrodeposits. The information presented in the previous report was organized on the basis of the various methods used. The same plan is followed in this report.

The general tone running through most of the replies was a genuine regret that no satisfactory quantitative method is available for measuring the degree of adhesion. There is a strong feeling that even the fairly quantitative methods for thick deposits are not practical because of the time and care needed in preparation of samples and the nature of the testing equipment required. It is the general belief that the use of present quantitative methods is limited largely to research laboratories. There is a strong desire for a simple, standardized and quick method suitable for regular production.

Much interest is shown in the problem. Some of the typical statements are quoted below. A. W. Hothersall of England has probably done more work on the subject of adhesion than any other person. A letter contains these interesting comments:

"There is much confusion of thought on the subject of adhesion, partly due to failure to define terms properly. It is most important that descriptions of the results of qualitative adhesion tests are intelligible to those not associated with the workers, and also that different people dealing with this question do mean the same thing when they use the same words. For a long time I have stressed the importance of using defined terms to describe the degree of adhesion found in a qualitative test. I am extremely glad that the A.E.S., which has long been prominent for its work on improvement in the quality of electroplated coatings, is now taking up the study of adhesion. There is much to be done in this direction, particularly in developing methods for assessing the adhesion of relatively thin deposits. I am not aware of any other laboratory in this country or in Europe, where the question of adhesion is being specifically studied. I shall look forward with great interest to the results of your work and if there is any way in which I can be of assistance to your Committee, please do not hesitate to write to me."

M. B. Diggin, Chief Chemist, Hanson-Van Winkle-Munning Company, expresses his feelings as follows:

"I do hope that your Committee makes some progress in developing quantitative methods for determining adhesion and that the methods are simple enough to be applied to formed articles. We wish you success in this undertaking and shall be glad to assist in any way possible."

As stated in the previous report it is the policy of the author to submit the comments and ideas of the various contributors in their own words. In this way it is hoped to avoid mis-interpretations and coloring which might result from personal prejudice. The reader is also more free to form his own opinions.

Bending and Twisting Tests

Tests of this nature are in more widespread use than any others. In some cases the manner of application is extremely crude; in others a distinct effort has been made to carry out the tests so as to permit some degree of standardization and reproducibility.

Judging from the replies received, the Meaker Company ranks very high among those giving consideration to adhesion. E. H. Lyons, Jr., Chief Chemist, furnished considerable detailed information. The following are his statements on the bending and twisting methods used by his company as well as a number of steel companies engaged in electrogalvanizing:

"Our work deals principally with electroplated zinc on steel strip and wire, for which the adhesion requirements are extremely severe. We also test some zinc coatings on fabricated parts and castings, and occasionally cadmium coatings. Because cast and cold-worked zinc or cadmium have much lower tensile strength and hardness than the steel base and, we believe, than the bond between the base metal and the electroplate, the quantitative tests applied to copper and nickel coatings are believed to be inapplicable, and we are not aware of any attempts to apply them. Therefore, as far as we know, no quantitative tests for adhesion have been made on zinc and cadmium plates.

"The qualitative tests can be classed as bend tests and blister tests. The bend tests comprise bending or flexing of the plated steel in such a manner as the nature of the plated object will permit. The bending is usually done by hand and, because no mandrel is employed, the radius of bending is not standardized. It is usually small, however, less than ⅛ in., unless prohibited by the nature of the work. The bending is frequently reversed and repeated until the steel base is fractured. Any sign whatsoever, even microscopic, of peeling, chipping, or flaking of the zinc or cadmium plate, is taken as cause for rejection.

"There is a machine put out by Amsler for testing the bending properties of steel strip. A sample of specified size is clamped between a pair of jaws machined to provide mandrels of specified radius. The opposite end of the specimen is seized by a clamp which applies a specific tension. The sample is first bent 90° to one side and straightened, then 90° to the other. This is repeated until the specimen breaks, and the number of bends withstood is re-

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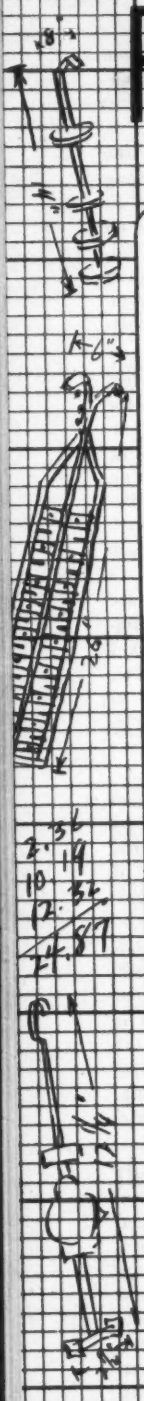

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corded. Its chief use, so far as we have observed, is in detecting hydrogen embrittlement of the steel. This machine has been proposed for a standardized bend test, but inasmuch as almost any electroplated zinc or cadmium coating will withstand the test, it has never come into use. Our own laboratory routine for testing adhesion on steel strip includes:

"(1) 90° bend test — Performed by seizing the specimen in a pair of pliers, and bending it as sharply as possible, first to one side and then to the other, until the steel breaks.

"(2) Crimp test — The steel is bent 180° back on itself and the bend is flattened by pliers or in a vise. On opening, the steel usually breaks before the bend has been straightened, the fracture having been initiated during the flattening.

"(3) Twist or rocking test — Outlined in Trans. Electrochem. Soc. **84**, 288 (1943).

"The last test is the most severe because specimens which withstand the first two may fail in the last. Attempts to apply the Erichsen cup test to electrogalvanized strip steel as a test for adhesion have been discouraging, doubtlessly because the zinc is ductile enough to flow in this test.

"The requirements on strip steel are unusually severe because the material is frequently severely formed, bent, twisted, folded, stamped, or drawn after plating. The same is even more true of steel wire.

"The standard test for adhesion on steel wire consists in wrapping the wire around a mandrel having the same diameter as the wire. It is important to twist the wire around its own axis as well while making this wrap, so that all elements of the surface will be subjected both to stretch on the outside and to compression on the inside. The resultant product is a coil of wire having twenty or thirty turns around the circumference of a straight portion of the wire. Close straight turns must be made to provide the greatest stringency of test. A crude lathe is often helpful.

"Although it is very difficult for most hot galvanized wire to meet this test without flaking of the coating, it is passed so readily by electrogalvanized coatings as to be meaningless for all intents and purposes. Nevertheless, it is commonly carried over from hot dip practice.

"Failures are sometimes noted on wrap testing hard steel wire and copper wire, but on stripping the electrogalvanized coating it will be found that the base metal itself has cracked. This is not regarded as the fault of the coating or its adhesion.

"Sometimes failures are noted on the inner smaller part of the wrap where the coating is under compression, although the stretched portion is perfectly adherent.

"Our laboratory routine for testing adhesion on round wire is as follows:

"(1) Wrap or 'button' test — Includes the steps described above: (a) wrap, (b) unwrap, (c) reverse wrap, and (d) unwrap. In (c) the identical wire specimen which has been unwrapped from the coil formed in (a), is rewrapped in the opposite direction to form a second coil, inside-out with respect to the first coil. Some steels will break in (b), (c) or (d).

"(2) Crimp test — The wire is bent 180° sharply back on itself, and squeezed as far as possible in pliers or vise. The highly stretched outer bend is examined.

"(3) Hinge test — The crimp formed in (2) is opened out carefully. The steel which has started to fracture in forming the crimp now parts along the fracture line. While the break is being observed with a low power magnifying glass, the fracture is opened until the steel has entirely parted and a portion of the zinc coating remains intact (though stretched) as a hinge joining the two pieces of steel. The adhesion of the hinge, and of the broken coating around the remainder of the circumference, is examined under the glass.

"As previously stated, the slightest sign of detachment of the zinc coating from the steel is cause for rejection, in any of the above tests."

The twist or rocking test referred to was briefly described by Lyons during the discussion of his paper on "Electrogalvanizing of Strip Steel". In answer to the question by C. G. Fink, "Do you not make any ductility tests?" Lyons replied:

"Yes, they are usually bend tests. We have recently been introduced to a test which is more severe. The strip is bent into a V-shape with handles (*our Fig. 1*) and then it is given repeated bending in a

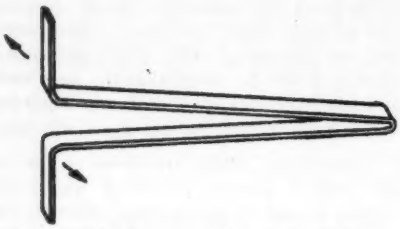

Fig. 1. Rocking or twist test specimen, bent into V shape, is twisted as shown by arrows, then in reverse direction; twisting is repeated until failure occurs.

direction perpendicular to the plane of the V, which results in a rolling twist at the point. A satisfactory electrogalvanized coating will stand such twists until the steel breaks, which in some instances may be after sixty or eighty twists."

It may be of interest to mention that the war pennies were blanked out of zinc-plated sheet steel, tested in this manner.

W. E. Moline of the National Cash Register Co. wrote as follows:

"Several tests for adhesion of electrodeposits have been used in our laboratories. All tests used have been of a series-comparative type, i.e. the tests were used to compare the adhesion on a series of identical test panels subjected to different treatments, etc. The first test is a bend test over a conical mandrel made by the Henry Zuhr Co. The apparatus consists of the cone, a clamp which holds the test panel tangent to the cone, and a lever and roller by which the panel is bent around the cone. This gives a bend of varying radius, and comparison is made between the maximum radii for cracking or flaking. Brittleness is an important factor in this test, so that comparisons of adhesion of different plates cannot be made."

The conical mandrel referred to is described in detail by H. G. Arlt of the Bell Telephone Laboratories, Inc., in an article entitled "Study of Conical Mandrel Test for Attached Lacquer Films", published in the A.S.T.M. Bulletin for December, 1937. The apparatus consists essentially of a cone 8 in. in length having a diameter of 1½ in. at the base and ⅛ in. at the smaller end. A bending mechanism is provided to wrap a finished panel closely around the mandrel. This device permits the elongation of coatings of from 2.2 to 28 per cent when applied to 1/32 in. thick panels of brass or steel. Fig. 2 shows a picture of this apparatus.

According to C. F. Nixon, Process Engineer, Ternstedt Mfg. Division of General Motors Corporation, his company makes use of practically every qualitative test described in the literature. He considers none of the methods wholly satisfactory, although each is considered to serve its purpose in indicating whether the process is operating properly. Concerning the bend test he states:

"Deformation is necessarily destructive and is usually practiced on parts that are processed in large quantities. The 180° bend test in government specifications is well known and need only be mentioned. Our C. V. glass channel is tested in a deformation test which consists of twisting it through 720° in 180° stages. Observations at each stage gives an indication not only of the degree of adhesion but also of the ductility of the plated coating. Absence of separation of the coating from the base at 720° constitutes satisfactory adhesion.

"A variant of the deformation test, usually performed on small parts, consists of clamping one end of the part in a vise, driving through a 45° angle with a hammer and examining the point of greatest bend. The effect of the hammer impacts is to put the metal to metal bond under high stress which causes separation if the adhesion is poor."

An especially severe bend test is known as the "Handkerchief Test" because of its similarity to the folding of a handkerchief. Concerning this test, Leonard E. Weeg, C. G. Conn, Ltd. has the following to say:

"I used this test during my ten years' association with the American Nickeloid Co., producers of pre-finished metals, and feel that it is completely reliable. Its use is limited to sheet steel products and it is destructive. However, it shows conclusively whether or not adhesion is good."

E. Sohn, American Radiator & Standard Sanitary Corp., tells of a drastic test which includes hammering as well as bending.

"We have for years been making an empirical test. We simply take a faucet body and by means of a hammer and a vise bend the spout end and the flange (if

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Build up the required rack coating thickness with simple dipping and convenient air drying—both at room temperature. And the result is a tough, resilient insulation, well able to take the hard knocks of normal shop handling and repeated racking and unracking of work.

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Chemical Resistance — Excellent for all plating cycles.

Toughness—Withstands repeated flexing and shop handling—cuts cleanly and easily at contacts.

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Unichrome Quick Dry Stop-Off 323—for chromium and other work requiring a stop-off that can be peeled off.

Unichrome Quick Dry Stop-Off 324—for high temperature solutions. It also resists vapor degreasers for a limited time.

flanged) in a prescribed manner and examine with a magnifier and also note if any flakes of the coating can be rubbed off the bent areas. Such an improvised test is, of course, not subject to any mathematical interpretation. It also gives some idea of the ductility of the coating which is also a matter of importance. Most of the methods thus far developed which permit mathematical calculation of the adhesion are painstaking. Generally the specimen must be specially prepared. Each test is almost a research project in itself, rather than a quick, simple and practical procedure, which is the preferred objective."

K. G. Soderberg of Graham, Crowley & Associates, Jenkintown, Pa., introduces two ideas, also mentioned by several others:

"Bending the plated part repeatedly until it breaks is also useful. Examination of the fracture under considerable magnification may show voids between the base metal and the coating which indicate poor adhesion. It is worthwhile to insert a knife edge in the void to judge the ease with which the coating can be peeled."

Many other informants included some form of bending or twisting but gave no additional information.

The Burnishing Test

This test was one of the first to be used and has always been considered of value especially for certain types of deposits. In the silver and gold plating industries it is one of the regular production operations,

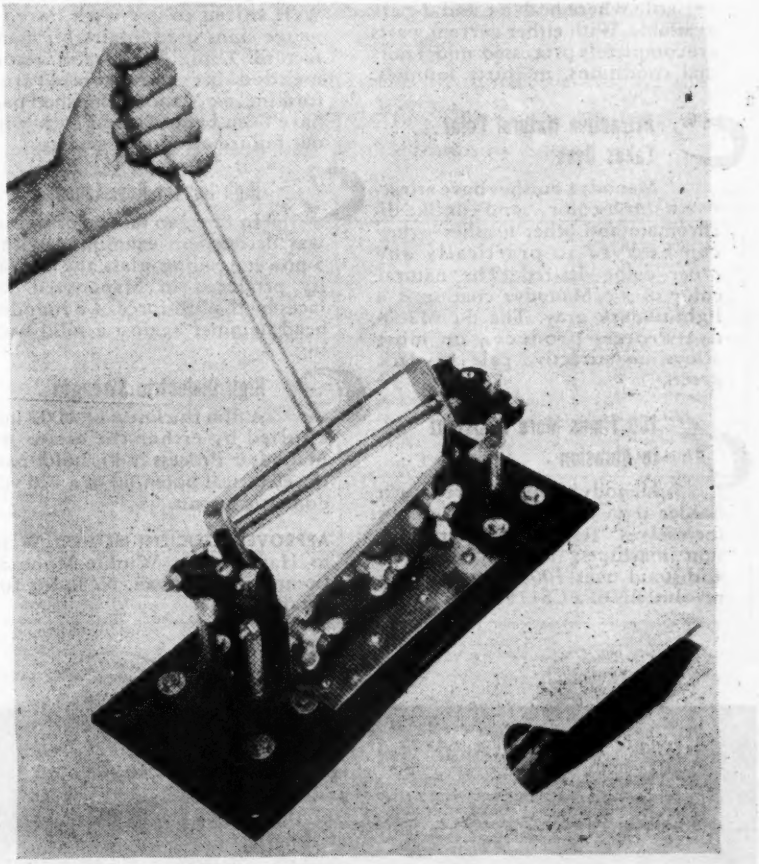

Fig. 2. Conical mandrel device whereby a single panel may be subjected to different degrees of bending in one operation.

HERE... *better protection for magnesium parts*

H-VW-M MANODYZ PROCESS*

In speed, in cost, in its ability to impart wear- and corrosion-resistance to magnesium alloys, the Manodyz Process is in stride with the vast recent improvements in the alloys themselves. The Manodyz Process produces a protective and decorative magnesium-oxide-silicate film on magnesium alloys *electrolytically*—a finish that is highly corrosion-resistant and an excellent paint base.

Fast...Uses A-C or D-C Current

Either a-c or d-c current is used with the Manodyz Process. Having different characteristics with each type of current, the Manodyz Process becomes extremely versatile where both a-c and d-c are available. With either current, parts are completely processed, under normal conditions, in thirty minutes.

Attractive Natural Color... Takes Dyes

Manodyz finishes have attractive *natural* color... and—unlike dichromate and other finishes – they can be *dyed* to practically any *other* color desired. The natural color of a-c Manodyz coating is a light-to-dark gray. The d-c Manodyz Process produces, on most alloys, an attractive pale-to-dark green.

100 Times More Resistant to Abrasion

Manodyz finishes are much harder than the magnesium alloys themselves. Tested on Taber abrasion machines, Manodyz finishes withstood over *100 times* as many revolutions of a CS17F wheel, without break-through, than did non-electrolytic finishes applied to magnesium alloys for the same purposes.

Manodyz Coatings Are Tough

The a-c Manodyz Process is well suited to use with narrow-gauge skins used in aircraft manufacture. Using bend radii recommended for room-temperature forming, a-c Manodyz finished parts have been bent 90° and back without failure of outside surface.

High Impact-Resistance

In tests, no failure of finishes was detected in examining with a 5-power reading glass the concavity produced in Manodyzed surfaces by the full force of a rounded-head hammer against a solid backing.

High Dielectric Strength

A film thickness of .0002 inch applied by either the a-c or d-c Manodyz Process will hold back the electrical potential of a 110 volt domestic circuit.

APPROVED, EFFICIENT METHOD. Write to Hanson-Van Winkle-Munning Company, Matawan, N. J., for full details.

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COMPARE THE MANODYZ PROCESS

For protecting magnesium alloys

On every vital count, the H-VW-M Manodyz Process has proved itself a superior means of producing an all-around protective coating on magnesium alloys. It protects the metal from the attack of chlorides, or from corrosive environments. It provides a good paint base by having the slightly acid surface necessary to combat the tendency of the metal to develop alkalinity. And—additionally—the Manodyz Process offers far more than non-electrolytic finishes in shielding magnesium alloys from *wear* and *abrasion*—and in protecting magnesium alloy parts, in contact with dissimilar metals, from *galvanic corrosion.*

Compare Manodyz with the acid-dichromate process on the chart shown here. Then – for further details on this superior finish—write to Hanson-Van Winkle-Munning Company.

	DICHROMATE	MANODYZ	MANODYZ ADVANTAGES
NATURAL COLOR	DARK BROWN	Gray (a-c) Pale Green (d-c)	Has an attractive natural color
SUSCEPTIBLE TO DYES	NO	YES	May be dyed practically any color
THICKNESS	Less than .0001" (gauge change less than .0001" LOSS)	.0004" (a-c) .0008" (d-c) (gauge change— a-c .0001" LOSS; d-c .0003" GAIN)	Requires less paint; remains protected if paint is damaged
WEAR-RESISTANCE RATIO	1	100 (a-c and d-c)	One hundred times the wear-resistance
CORROSION-RESISTANCE RATIO	UNSEALED: 1 (a-c) SEALED: 1 (d-c)	UNSEALED: 1-2; 1 (a-c) SEALED: (1½)-2; (1½)-(1¾) (a-c) (d-c)	Up to two times greater; especially with galvanic corrosion
COATING SOLUTION COST			As low as one-seventh the cost of dichromate

*Patents Pending

663

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and in general these industries have considered additional tests to be unnecessary. The test is limited, of course, to very thin deposits.

The best detailed description of a modern application is by Vincent Mattacotti of C. G. Conn, Ltd.:

"The method is particularly applicable to testing the adhesion of thin deposits with special reference to silver and gold plate. It makes use of a burnishing tool, generally of steel, as follows:

"The tool which is continually moistened with soap suds is held near its end, and considerable pressure is applied by the operator while he causes it to glide back and forth without removing it from the surface of the part being burnished.

"The tool must be free from surface defects and kept highly polished. Considerable pressure is exerted locally and causes any areas of plate which are weakly adherent because of poor preparation of the base metal or faulty technique in electroplating, to lift in the form of blisters. This method is not used as an inspection method, but is part of the production operations on band instruments and as such tends to catch defective plating mainly of the poor adhesion type."

C. F. Nixon reports that he used the method extensively for thin deposits of nickel and chromium because of its speed and non-destructive nature.

"Burnishing is a non-destructive test when applied to nickel plated parts. It is performed by moving a cylindrical smooth bar rapidly back and forth over the area being tested. If the plate rises, the adhesion is declared unsatisfactory. The test was applied to nickel and chromium plated brass parts on areas which experience had taught were most susceptible to poor adhesion. Since lack of adhesion in this case resulted from stray currents, occasional poor adhesion could be detected without damage to the balance of the parts."

It has been suggested that the method might even be made at least semi-quantitative by burnishing with a machine in which the pressure, rate of movement, surface area of burnishing tool, area of surface burnished, etc. could be standardized.

Ball burnishing barrels are in rather common use in regular production. At the same time, their use serves as an adhesion test. K. G. Soderberg suggests the possibility of developing a semi-quantitative test using a ball burnishing barrel:

"I have used burnishing tests to develop blisters but never under very controlled conditions. It may be possible to produce controlled conditions by means of a ball burnishing barrel using a given weight of balls and possibly relating the weight to the surface area of the parts being tested."

Impact Tests

There are various tests in use today that depend upon impact. Some use a very crude system of striking the object with a hammer of definite weight, some with a direct sharp blow and others with a glancing blow. The feeling is expressed that valuable information may be obtained by a given individual. Others slowly press a ball

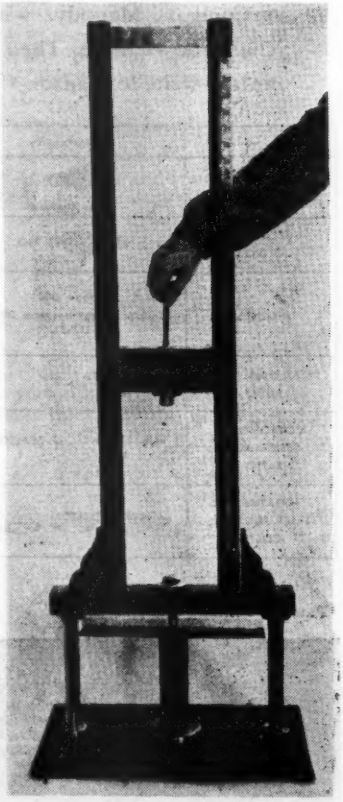

Fig. 3. Parlin-duPont impact tester.

or plunger against a plated object resting on a ring-shaped anvil. In a third commonly used variant, a known weight is allowed to drop through a known distance and hit the plated object which is supported over a ring-shaped anvil. The last device is the only one considered here.

A rather standard type is known as the Parlin-du Pont Impact Tester. W. E. Moline of the National Cash Register Co. reports that a variant of this tester is in general use by his company. He states:

"A modification of the Parlin-du Pont Impact Tester is used, in which a definite weight falls a definite distance before striking a steel ball of given diameter resting on the panel under test. No set standards have been established for the test, as it is used as a means of comparing a series of electrodeposits of equal thickness while holding the other test conditions constant."

Concerning the availability of this tester, R. O. Isele, E. I. du Pont de Nemours & Co., Parlin Laboratory, states:

"As regards availability of this equipment we wish to advise that we do not manufacture the apparatus other than for our own needs. However, we are attaching hereto for your inspection and use a photostatic copy of a blueprint for the construction of this equipment."

Copies of the blueprint are available on request.

The Parlin-du Pont Tester and a variant thereof pictured in "Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors" by Henry A. Gardner (Institute of Paint and Varnish Research, Washington, D. C.), are shown in Figs. 3, 4 and 5.

Another modification, shown in Fig. 6, is reproduced from a picture furnished by M. B. Diggin, Chief Chemist of Hanson-Van Winkle-Munning Co.

Concerning the use of this device, Diggin has the following to say:

"The modified cup testing apparatus was made in our own shop and has been very valuable to us in studying the ductility and adhesion of electrodeposits. The plated

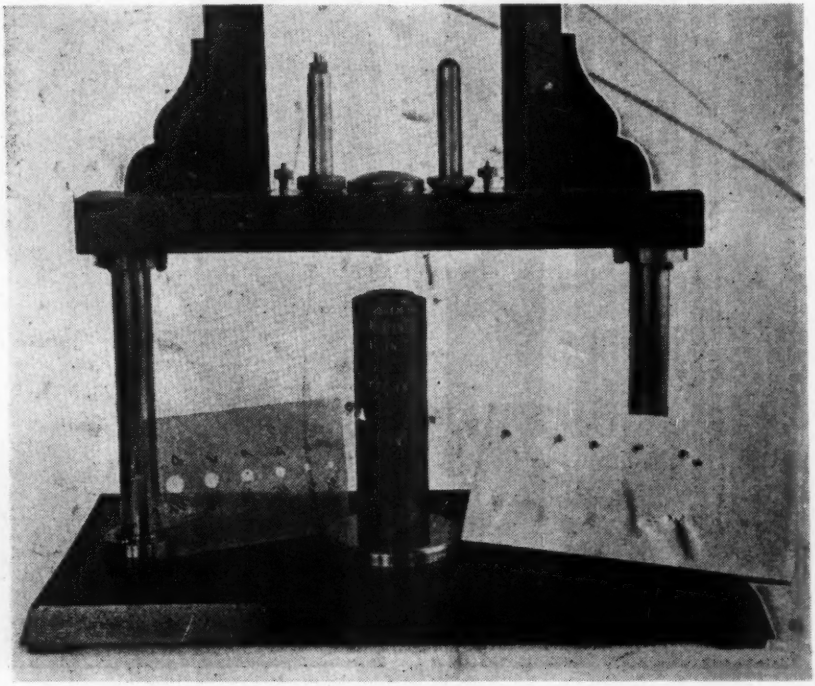

Fig. 4. Lower portion of Parlin-duPont impact tester.

sample is placed on the lower jaw and a hollow, threaded cylinder is screwed down on the panel so that it is held firmly in position. The hardened steel plunger is inserted in the hole and allowed to rest on the panel. The weighted block which is free to slide up and down the guiding column is fitted with roller bearings to decrease friction. The weight is brought to a height which depends upon the gauge and temper of the stock being tested. When released, it descends and strikes the plunger which draws the cup in the panel.

"We usually draw a cup just short of the breaking point of the metal. This point can be determined by making several trials. The panel is then inspected for evidences of cracking or lifting of the deposit.

"We realize that this is not a quantitative test, but nevertheless through experience we have been able to relate the results of this test with surface requirements."

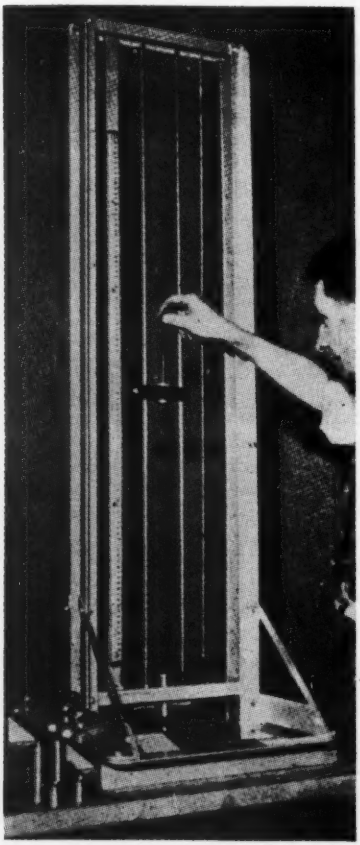

Fig. 5. Pratt & Lambert variant of Parlin-duPont impact tester.

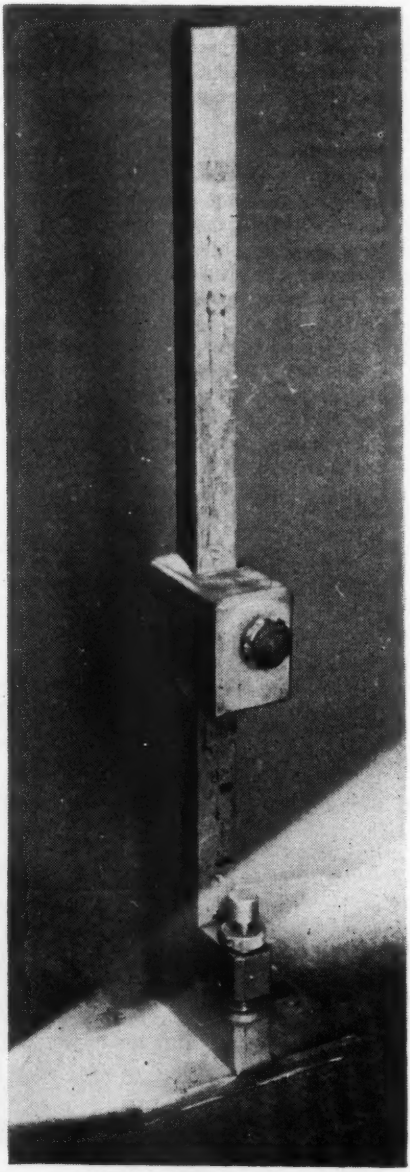

Fig. 6. Hanson-Van Winkle-Munning variant of Parlin-duPont impact tester.

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Is Your Plating Bath as Clean as the Water Used in Your Final Rinse?

Heating Tests

Many heating tests have been used. There are two main variants, each based on a different principle. In one, the heating causes liberation of gas which has been absorbed by the base metal, or it causes evaporation of liquid absorbed at the interface or held in pockets in the base metal. The pressure of the gases results in the formation of blisters. In the other, the plated object is raised to some high temperature, then suddenly cooled. The difference in the coefficients of expansion of the electrodeposit and base metal results in severe strain at the interface which produces cracks, blisters or peeling. For several years there have been strong differences of opinion as to the influence of heating on the adhesion of an electrodeposit. It appears now that both sides are right. The result depends largely upon the material of the plate and the base, F. C. Mesle, Superintendent of the Bearing Plating Division, Oneida, Ltd., has been one of the most active investigators of this problem. He has this to say:

"It was my intention to prepare a group of specimens with different degrees of bond strength to be used as an exhibit, but some difficulties were encountered which made my plan impractical.

"I had some plated specimens that had an 'as plated' bond strength of about 1000 psi. This would be considered poor bond. On heating these pieces to from 500 to 950°F for 30 minutes (less time may have accomplished the same results) the bond strength was improved to better than 35,000 psi; at this pull the deposited metal broke but did not lift from the base. It is reasonable to call this bond perfect.

"A longer time at room temperature seems to accomplish much the same result as heating. The specimens that could be lifted with 1000 psi pull shortly after plating, could not be lifted with 35,000 psi six months later. Tests made at intervals during the six months' period showed improvement in bond strength with time, but the exact time required to change from poor to perfect bond was not determined. The above illustrates how difficult it is to prepare an exhibit that could be used by others to check on results or test methods.

"I will send you specimens that illustrate the points mentioned above. Those marked 1 to 4 are sections cut from the same bearing. Therefore, it is reasonable to assume that plating conditions were the same on all four pieces. The plating was done so that the deposit could be lifted from one end to give a handle for the adhesion test. These specimens were plated in October, 1944.

"No. 1 shows how poor the bond was 'as plated'; about 1000 psi pull was required to separate the deposit from the base.

"No. 2 was heated to 900°F for 20 minutes. The deposit was peeled back about 1½ in. before heating to establish that the bond strength was same as in No. 1. After heating, the bond strength was greater than the tensile strength of the deposit.

"No. 3 is the same as No. 1 except that the bond test was made in May, 1945. In this case, time (around six months) and room temperature have improved the bond strength so that it is again greater than the tensile strength of the deposit.

"No. 4 is sent to permit you to make the bond test on a tensile machine. I am confident the deposit will break rather than separate from the base. What happens to the first ¼ in. should be ignored.

"The fact that heating generally improves the bond strength of electrodeposits indicates that any test method which requires heating of the test piece, such as soldering lugs to the plated surface, and then applying pull to separate the deposit from the base, does not give a correct indication of the bond strength 'as plated'. If the solder test is used, the production lot should be heated to same temperature.

"I stated above that heating generally improves poor bond. Sometimes the reverse seems to be true. Specimen Nos. 5 and 6 illustrate this.

"No. 5 shows good bond 'as plated'.

"No 6 has been heated to 900°F but the bond strength is definitely poorer than before heating. Nine months' time and room temperature have not produced the same effects as the heating. Why? I would like to know the answer."

George B. Hogaboom, Sr., Consultant on Electrodeposition and Finishing of Metals, writes on the question of heating:

"It is believed that the Mesle method of heating the specimen does not give correct results. It appears that Mesle overlooked the fact that upon heating silver

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Like the super-fast modern planes . . . Codman Ventilated *Non-Fray* Buffs are built for speed.

- These perfected *Non-Fray* buffs have been scientifically designed and tested to allow proper ventilation at high speeds.
- They have no equals for efficiency and stamina at high speeds.

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TYGON PAINT

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Tygon Paint, Tygon Tempro-tec, Tygon Tape and Tygon Tubing are usually available at leading plating supply houses. If not write direct.

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TYGON PAINT, a liquid formulation of Tygon sheet stock (the flexible plastic used to line plating and pickle tanks), will resist spillage or fumes from all plating or pickle solutions. Ideal for lasting protection for walls, structural steel, tank and equipment exteriors, fume hoods, etc. Available in white, black, clear, gray, red, green, and aluminum.

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Hook and Rack Coverings—Tygon flexible tape and tubing for protection of hooks and racks. Will not take a plate; resists all plating solutions; lessens current losses.

U. S. STONEWARE

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plated nickel-silver, diffusion of the silver coating into the base metal occurs at certain temperatures. When diffusion occurs, then the bond between the base metal and the coating is improved in many cases. If, however, the diffusion layer is brittle, the peeling of the coating is caused by fracture rather than non-adhesion. Some metals do not diffuse into each other, e.g., silver and steel. If copper is used as an undercoat it may diffuse into both the steel and the silver. It appears to me that the good adhesion obtained on silver-plated aircraft bearings is due to the diffusion of the nickel undercoat into the steel and the silver. The extent of diffusion is also of importance."

Hogaboom continues in another letter:

"If flat, smooth surfaces of cadmium and copper are held tightly together, within a month the cadmium will have lost weight and the copper gained in weight.

"If a sheet of polished brass is cadmium plated and the cadmium removed within a few hours by immersion in a solution of ammonium nitrate, the lustre of the brass is hardly affected. If, however, the plated piece is permitted to stand 48 hours before immersion in the ammonium nitrate solution, a loose, black film will be found on the brass and the lustre of the brass is destroyed.

"When cadmium plated brass was heated to about 350°F, the deposit blistered. It is my opinion that diffusion had occurred, that a brittle layer of cadmium-copper-zinc was developed by the heating and that it was the cause of the blistering.

"In his book 'Cadmium — Its Metallurgical Properties and Uses', N. E. Budgen on pp. 140-142 states that while small amounts of cadmium hardens copper, 6% of cadmium in the copper makes 'it break up into short pieces and fall away'. And 'Further increase of cadmium (above 1%) does not harden the alloy as would be expected from the increased proportion of the hard, brittle constituent Cu_2Cd, which is formed. . . . '

"In his study of the electroplating of zinc die castings (Trans. Electrochem. Soc. **66**, 427 [1934]) Castell found that a brittle diffusion layer was formed between the copper plate and the base metal."

K. G. Soderberg comments on Hogaboom's last-quoted communication:

"I can confirm the rapid diffusion which takes place in cadmium plated brass at room temperature. From studies of electrical contact resistance between cadmium plated copper surfaces, I concluded that the rate of diffusion between cadmium and copper is exceedingly slow at room temperature but rather rapid at temperatures as low as 210°F. Blistering is not a normal phenomenon on cadmium plated brass or copper which have been kept at ordinary temperatures."

A. E. Foche, Diamond Chain & Mfg. Co., states:

"After plating, the test pieces are tempered at 375°F for 3 hours to remove hydrogen. We have found that this step is important. In some cases pieces which have not been tempered have shown poorer adhesion than those which have."

An approach to a semi-quantitative heating test is suggested by E. M. Hayden of The Stanley Chemical Co.:

"The higher the temperature or the more heat applied, the higher will be the degree of blistering or peeling of an electrodeposit having poor adhesion; and the poorer the adhesion, the worse the blistering. The resistance to blistering upon the application of heat is then an indication of the degree of adhesion. We use 350°F for copper-nickel-chromium deposits on die castings, red heat for nickel directly on steel. These tests are practical for proving a cleaning cycle prior to plating. It is interesting to note that if satisfactory adhesion is present to begin with, the application of heat will further enhance the adhesion. Induction heating has been proposed as a means of increasing adhesion by effecting an actual alloying of the base metal and the electrodeposit. We do not consider the two methods described above as being novel, but they are a practical means of determining satisfactory adhesion. Obviously, the bend test results in a damaged article. The heating test has the advantage of not damaging the test piece, yielding an acceptable product if the adhesion is satisfactory, and may be used for items for which the bend test is not applicable. Perhaps with the advances being made in induction heating, a simple

practical method, closely measuring the degree of adhesion, can be worked out."

An experience which has been mentioned several times, especially by those who plate on aluminum, is well described in the communication from E. H. Lyons, Jr. While he speaks of days before blisters develop, others have spoken of weeks:

"Blisters sometimes develop in zinc and cadmium coatings on storage at room temperature. Sometimes 5 or 6 days are required for the blisters to develop. They are believed to be inflated by the small amount of hydrogen absorbed during plating, but will not show up unless the adhesive bond is unsatisfactory. Excessive hydrogen absorption sometimes produces blisters in the steel surface, but iron may then be seen or detected on the detached portion of the zinc coating. Separation between the electrodeposit and steel base are indications of poor adhesion.

"Instead of waiting a week for blisters to develop, the specimen may be heated for an hour at 300-400°F, or for a shorter time at 500°F.

"For steel strip and wire and certain other plated parts, the blister test is applied by holding the specimens above a Bunsen flame until the zinc softens and 'fuses', which can readily be seen with the naked eye. Often a certain amount of wrinkling of the surface and sometimes a distinct yellowing accompany the 'fusion'. The temperature at which zinc softens and becomes plastic but does not actually melt is believed to be about 600°F.

"Any blisters which develop during heating indicate faulty adhesion. There is a tendency to regard the estimated temperature at which the blisters appear, and their size and number, as a semi-quantitative measure of adhesion, but we do not believe this is correct; they probably measure only the rate and amount of evolution of hydrogen from the steel.

"Following the blister test, it is wise to apply a bend test to the 'fused' area and its immediate neighborhood. The most critical portion appears to lie ¼ to ⅜ in. outside the 'fusion' zone. Failure here is not regarded as cause for rejection, but it indicates fault in the cleaning process which, if not corrected, will ultimately lead to failure in one of the other tests."

A suggestion for a test of comparative adhesion for one series of panels is given by W. E. Moline:

"Poor adhesion is measured comparatively by heating a series of panels in a constant temperature oven at 350°F for one hour. The number of blisters appearing per unit area is taken as the basis of evaluation of any one series."

The heating test which depends upon the difference in coefficient of expansion of deposit and base metal has been mentioned frequently. One such test is well described by C. H. Greenall, Lt. Col., Ordnance Dept., Frankford Arsenal:

"It has been found in a limited number of experiments at this Arsenal that cyclic exposure of coated specimens to subzero temperatures followed by room temperature is a sensitive method of detecting poor adhesion of nickel and chromium coatings. Thus far only —40° and —70°F have been tried. It is felt that a temperature as low as that of liquid air may be useful in separating electrodeposits from base metals having different temperature coefficients of expansion."

The "Black Light" or "Fluorescent" Test

This is one of the newer tests which nevertheless has been mentioned in several reports. From these, and from conversations, it is evident that the method is applicable only in special cases, and even then its value is questionable. It depends upon the penetration of oil between the coating and base metal. Some have used the method in connection with the heating test to detect whether loosening has taken place or not. It does indicate complete lack of bond at edges, but does not show a loose deposit even where a blister exists unless there is a break in the deposit. It is more a test for porosity than for adhesion, in fact, it shows only a complete lack of adhesion.

The Erichsen Cup Test and Variants

Extrusion tests have appeared under various names in the literature. The ones most commonly used are the Erichsen cup test or simply the cup test, the Olsen ductility test and the Romanoff flanged cap test. Several have used the regular Brinell machine to force a ball into the sample. From

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the extent that these tests are reported in the literature, one would gain the impression that extrusion tests are in general use in industry, but in all the correspondence received such tests have been mentioned in only a few instances and then without details or critical comments. A possible explanation is that most of the published literature comes from research laboratories where the necessary equipment is available, while a large part of the correspondence came from production operators and managers.

It might be well to state here that one gets the impression from the literature that the value of the various extrusion methods is highly questionable. They depend very much upon the nature of both the coating and the base metals. One somewhat favorable report was received from L. R. Westbrook, Research Manager of the Electroplating Division, E. I. du Pont de Nemours & Co. He states:

"Recently we have had occasion to use the standard Olson machine for measuring plate deformability and found that poor adhesion was very readily demonstrated. While I doubt that this technique could be adapted to quantitative measurement of adhesion, something might be worked out in connection with deformation tests."

The Scratch or Scratch-and-Knife Test

Here again the published literature, particularly the older literature, gives the impression that tests of this nature were in common use, but the private reports contained only an occasional mention of them. Two explanations are offered: There has been considerable improvement in adhesion during the past few years, and thick deposits are more common. From a conversation with the man in charge of adhesion testing for a large bearing manufacturing company, it appears that a test somewhat similar to the scratch test for thin coatings is being used for the thick linings of bearings. Parallel grooves are machined through the lining to the base metal, the distance between them depending upon the thickness of the lining; then another set is machined at right angles to the first. A blunt chisel is placed against the rectangular sections thus formed and hit a sharp blow with a hammer. This is considered a highly effective test for linings made of relatively hard metal, but has little value for soft metal.

The Chisel Test

This test has come into fairly general use recently, largely on the thick coatings used on bearings. C. F. Nixon states:

"The chisel test was used on work of such size and shape that the deformation test could not be applied and on plate of considerable thickness. One variation of the test is to place a sharp chisel back of a plate overhang, and give it a sharp hammer blow. If the adhesion is good, the plate will either break away or cut through without affecting the bond between base metal and plate.

"A second chisel test consists of cutting through the plate with a sharp chisel and when the base metal is reached, determining whether the separation is plate from plate or plate from base."

A sharp chisel is used in the above procedure. Vincent Mattacotti describes a procedure in which a blunt chisel is used:

"The chisel method has been used successfully to determine the adhesion of very heavy electrodeposits of silver, .040-.060 in. thick, over steel.

"The chisel shall be ⅜ in. wide and shall be ground with a bevel on one side only, leaving the back flat and straight. The cutting edge shall be a flat surface 1/32 in. in width and 90° to the flat back in order that a pushing action rather than a cutting action be obtained. The chisel shall be maintained in proper condition and re-ground when necessary to maintain the flat back. A 12 oz. ball peen hammer shall be used.

"The procedure to be followed in chiseling a bearing is: The plated bearing shall be hung on a proper fixture with proper stops. The chisel shall be held vertically with the flat side against the flange of the bearing and shall be in such a position that it will pass through a slot provided for this purpose on the fixture. The chisel shall be struck by the hammer until the silver either tears or is cut through. Any silver tear shall be examined for depth by further chiseling if necessary. A tear more than ⅛ in. deep shall be cause for rejection.

"The chiseling shall be performed around the flanges of the bearing in three locations equally spaced."

Various other modifications of the chisel test are in use. One which I have seen used with considerable success consists in taking a strip of any convenient width and sawing nearly through the base metal, then bending it at right angles until the base metal, or base metal and deposit break. If the adhesion is not too good, the deposit will part from the base metal to a greater or lesser degree. Even if there is no visible parting between the deposit and base metal, a thin, sharp chisel hit with a light hammer may still loosen the deposit. If not, the adhesion may be considered perfect. A very good idea of the bond may thus be obtained.

MANUFACTURE OF COPPER FLOAT BALLS by Electrodeposition

By GEORGE B. HOGABOOM
New Britain, Connecticut

BALLS can be made of pulp paper on which the copper is deposited. The method used is the same as that for making toys and small ornaments. A split mold is made of cast iron in which the required amount of moist paper pulp is placed. Through a nozzle reaching to the center of the mold air is introduced at a pressure that will "blow" the pulp to the sides of the mold. The ball is removed and thoroughly dried.

Instead of using water, one can saturate the paper pulp with a thin solution of a plastic compound.

When the paper pulp ball is dry, it is sprayed with or dipped into a thin solution of shellac, wax, or a plastic compound which serve to render the paper impervious to water.

Copper bronze powder that is free from grease, e.g. a "lining" powder, is mixed with relatively small amount of cellulose nitrate lacquer that contains not more than 5% of gum. A lacquer for polished silverware is suitable. The mixture is sprayed on the paper ball and allowed to dry in air.

If the paper pulp is well impregnated with the waterproofing material and a small hole is left in the ball, a holder can be made which permits the ball to be filled with solution on immersion in the electroplating bath. If the ball is completely sealed, a device to hold the ball forcibly under the solution will have to be used.

The copper is applied in a copper sulfate solution, the composition of which may be: Copper sulfate — 28 oz.; sulphuric acid — 6-8 oz.; water — 1 gallon. Operating conditions are room temperature and a current density of 20-60 asf.

A low current density should be applied until the ball is well covered with copper, after which a higher current density can be used. Air agitation of the solution may be employed to advantage when the higher current density is used.

If a smooth deposit is required it is advisable to filter the solution continuously during operation.

Another method is to make a mold with a cavity in the shape of a hemisphere. Any metal, e.g. cast iron, may be used as mold material. The mold is given a coating of a hard wax, e.g. canauba wax, not less than .005 inch thick. The wax can be applied by repeated dipping into molten wax or by spraying the wax which has been dissolved in a suitable solvent. It is probable that a high grade floor wax can be used.

When the wax is dry, copper bronze in lacquer can be applied by spraying and plating carried out as previously described.

After plating, the application of a low heat will permit the electroformed copper shell to be removed from the mold.

Suitable allowance must be made in the construction of the mold to permit trimming and soldering together of the two halves of the copper shell. If desired, the solder joint can be covered by plating the ball in a standard cyanide copper bath.

Balls can also be made from thin metal and electroplated in a copper solution to obtain the required strength.

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CONVENTION *News*

With snow storms raging and the temperature hovering all too close to the zero mark, it is rather difficult to realize that June is rapidly approaching. But it is, and time-wise that puts the 1946 A.E.S. Convention, at Pittsburgh, just around the corner. Consequently, now is the time to make your plans to attend this meeting that promises to be the biggest and best in A.E.S. history.

Although the situation is expected to ease somewhat before June, hotel space remains restricted. To firms planning to send several men to the Conference we strongly recommend reservations of double rooms instead of single wherever possible. This will help insure first class hotel accommodations for the maximum number of Convention visitors in the seven or eight really fine hotels of Pittsburgh.

Conference headquarters will be at the William Penn, a Statler hotel. We remind you again that the dates are June 17-20 inclusive, and ask that you note that the four-day Convention plan is being resumed with this Pittsburgh meeting.

Publicity notices and items about the Convention Program will soon appear in a dozen or more trade journals. All material for inclusion in the Convention Program, except advertising, should be in our hands not later than March 15.

W. J. HENNESSY,
Publicity Chairman

RACK COATINGS

(*Continued from page* 157)

ner consumption and the attendant mixing. One should never attempt to use ordinary lacquer thinner for reducing the consistency of rack coating material. Special solvents are required for the special synthetic resins, and only the thinner supplied by the manufacturer should be used.

Since use of rack coating materials involves handling of volatile, flammable solvents, all steps should be carried out under conditions which comply with Underwriter's Specifications and local ordinances.

Some platers think nothing of spending hours in designing and making beautiful, well constructed racks only to do a haphazard, slip-shod job of coating which limits the service performance of the rack and shortens its life. Others have learned the advantages to be gained by the use of the proper materials and by taking that little extra time and effort which are required to do the job right. They are rewarded by having long-lived racks which need a minimum of attention.

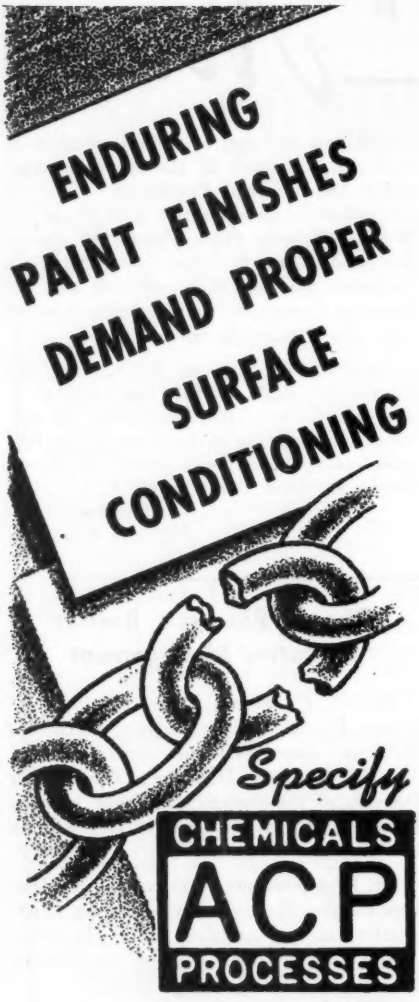
Use a good coating — follow instructions — obtain good results!

Rheem Research Revises Executive Management

Mr. C. C. Martin, Vice President of Rheem Research Products, Inc., Baltimore, Md., has announced the appointment of Mr. H. C. Irvin as Manager of the Eastern Division of the company effective January 15, 1946. Mr. Irvin's headquarters will be in Baltimore.

Mr. John Neerhout will continue as Manager of the Western Division with headquarters in Los Angeles, Calif. The work of the two divisions will be coordinated through Mr. Martin.

Mr. Irvin joined Rheem Research in February, 1944 as Plant Manager and in April of last year was appointed Manager of the Marketing Division. Previous to joining the company, he was associated with the Bendix Radio Corporation at Towson, Md. as a Management Engineer of the staff of the General Manager. Before that, Mr. Irvin was a Development Engineer with the American Brake Shoe Company; operating from that concern in Baltimore, New Jersey, New York and Detroit offices.



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By DR. HAROLD J. READ

TECHNICAL DATA ON PLASTICS. Plastic Materials Manufacturers' Association, Washington 5, D.C., 163 pages, $1.50.

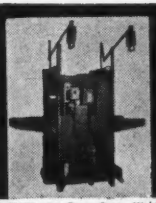
This book is in no sense a general, descriptive textbook on plastics; it is, rather, just what its name implies — a handbook of data, mainly physical, on a wide variety of plastics. Quoting from the introduction to the book: "The purpose of TECHNICAL DATA ON PLASTICS is to acquaint the user with the nature, particular merits and utility of various plastics and with property values, as measured by recognized methods, commonly to be expected in available forms and modifications of the various basic compositions." In order to simplify the presentation of the data, individual materials have been grouped according to composition and properties, and the data is given for these groups. Hence minor variations with respect to the values for a particular product may be expected.

The various plastics are divided into twenty categories according to their chemical composition. For each of these groups the data are arranged in a tabular form which is uniform throughout the volume. The tables are subdivided into sheets bearing data on electrical, mechanical and fatigue tests printed on yellow paper. Data relating to ease of fabrication and miscellaneous tests are printed on pink paper. In many cases additional data are represented in the form of curves showing the relationship of a given physical property to some variable condition; for example, tensile strength is plotted as a function of temperature, and stress-strain curves are given for tension, compression and flexure tests. Almost all of the tables are extensively annotated with footnotes indicating special properties, test methods, etc.

It is recognized in the introduction that it is necessary to base the data on well-defined and generally accepted test methods. This is particularly true in evaluating plastics where the values obtained for physical properties may vary rather widely with the conditions of testing. Insofar as is possible, the values listed in the tables of this volume are those obtained from the test specimens and by the methods of test which have been adopted as standards or tentative standards by the American Society for Testing Materials. These methods are not discussed in the handbook, but it is important that the user should be familiar with them and know their significance.

Each set of tables is preceded by a short introduction which describes briefly the chemical composition of the plastic material concerned, its method of manufacture, distinctive properties, some typical uses and the forms in which it is made available to fabricators. These introductions include tabulations of the companies manufacturing the material under discussion and the trade marks or trade names of their products.

While much of the information in the handbook is of interest mainly to designers and fabricators, the electroplater may find much of interest in the data on chemical resistance, heat resistance, water absorption, etc.



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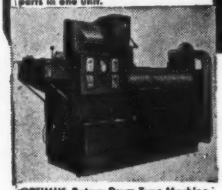

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THE problem of machine washing of metal parts prior to, and washing and drying the parts after, the plating operation, is one that cannot adequately be met with any one standard piece of equipment. Obviously, the method of handling the parts, the kind of parts themselves, as well as the nature of the preceding and succeeding operations, all have to be taken into serious consideration. Recognizing the complexity of the problem, and knowing Industry's desire for simplicity, OPTIMUS engineers, who are specialists in the whole range of metal cleaning operations, have designed a minimum series of standard models to cover the entire scope of washing, rinsing and drying as related to plating. The result is a limited number of models of proven design that cover a wide number of conditions.

A glance at this table will give a quick idea of the small number of basic type of units (7) and the large and complete range of conditions (12) met:

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	Rotary Drum Washing of small parts			Model No. E-1
	After Racking		Single Racks Racks in Bulk	Model No. C-1 Model No. D-1
AFTER PLATING	After Barrel Plating		Rinsing Rinsing & Drying Drying	Model No. E-2 Model No. E-6 Model No. E-3
	After Plating On Racks	Single Rack	Rinsing Drying	Model No. C-2 Model No. C-3
		Continuous	Rinsing Drying	Model No. D-2 Model No. D-3

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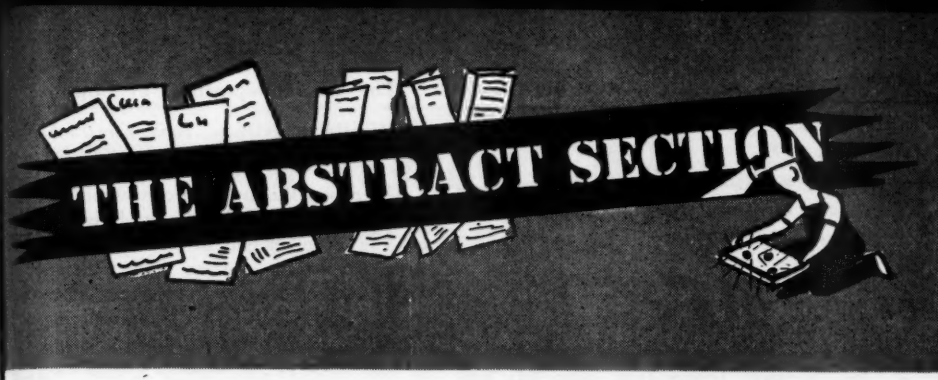

By FRANK K. SAVAGE

Chairman, Program and Educational Committee

Electricity for the Plater I

D. A. COTTON. *Products Finishing* **9**, **No. 11**, 36-42 (1945).

The early history of electricity is presented with particular emphasis on static electricity.

RAYMOND F. LEDFORD

Electricity for the Plater II

D. A. COTTON. *Products Finishing* **9**, **No. 12**, 54-62 (1945).

The early history of voltaic electricity is presented together with a discussion of its magnetic effects. Definitions of ampere, volt and ohm are given.

RAYMOND F. LEDFORD

Electricity for the Plater III

D. A. COTTON. *Products Finishing* **10**, **No. 1**, 66-74 (1945).

The Ohm's law, series and parallel resistances, and the resistance of various metals and sections are discussed.

RAYMOND F. LEDFORD

Electricity for the Plater IV

D. A. COTTON. *Products Finishing* **10**, No. 2, 66-74 (1945).

This article deals with electrical resistance of metals and the effect of temperature on resistivity. Actual examples and factors are given for resistance of bus bars, rheostats, heaters and tanks.

RAYMOND F. LEDFORD

Electricity for the Plater V

D. A. COTTON. *Products Finishing* **10**, No. 3, 100-06 (1945).

A resumption of the discussion of the current carrying capacities of conductors, with emphasis on the circular mill area allowed per ampere. Tables for copper strip and rod are included.

RAYMOND F. LEDFORD

Magnetic Tester

E. S. SPENCER-TIMMS. *Metal Industry* (London) **67**, 298-300 (1945).

A new instrument is described, with illustrations, which measures the thickness of non-magnetic coatings on steel. A pivoted beam carries a rod shaped permanent magnet at the end of one arm and a weight free to move along the other arm which is arbritrarily divided into suitable units. The magnet is 2 in. long by 7/32 in. dia. with hemispherical lower end. Several sizes of weights are provided for different thickness ranges between .01 and .0001 in. The weight is moved along the beam by rotating it with the finger; contact with the sample is made by hand. The instrument is said to be accurate within $\pm$ 10% of the thickness and is subject to the usual limitations of magnetic thickness testers.

L. M. MORSE

The Electrodeposition of Nickel-Cobalt-Tungsten Alloys from an Acid Plating Bath

PAUL F. HOGLUND and M. L. HOLT. *Trans. Electrochemical Soc.* **88**, Preprint 24, 11 pp. (1945).

The most satisfactory aqueous bath found was a modified Fink and Lah borate type nickel-cobalt bath to which was added a small amount of sodium tungstate. The effect of bath temperature, bath pH and current density on the cathode current efficiency and on alloy composition was studied. The tungsten content varied from less than 1% to about 10% and within this range was found to increase with (a) increased tungsten content of the bath, (b) increased bath pH, and (c) decreased current density. In general the appearance of the deposits was improved and the tungsten content decreased slightly by raising the bath temperature. The cathode current efficiency was found to be somewhat less than that of the nickel-cobalt bath and varied somewhat with conditions of electrolysis. A bright, adherent nickel-cobalt-tungsten alloy was obtained at a current density of 1 to 3 amp/dm^2 in a bath containing 240 g/l $NiSO_4.6H_2O$, 21 g/l $NiCl_2.6H_2O$, 12 g/l$CoSO_4.7H_2O$, 30 g/l H_3BO_3 and 3.6 g/l $Na_2WO_4.2H_2O$ of a pH of 4 to 4.5 and a temperature of 65°C to 75°C. The alloy deposits were found to have no special corrosion-resistant properties.

LEONARD E. WEEG

Throwing Power of Anodizing Baths

R. S. HERWIG and A. LEIGH. *Iron Age*, **156**, No. 25, 51 (1945).

A modification of the Pan method is used for measurement. Two cast aluminum plates with sides faced off and one surface of each plate lap ground are bolted together and holes of varying depth bored in the joint. After use the plates are separated by loosening the bolts and the depth of penetration measured. When the oxide coating color is very light and difficult to see, the coating can be dyed black. The test gives valuable comparative results.

C. W. SMITH

The Electrodeposition of Copper

HERBERT BANDES. *Trans. Electrochemical Soc.* **88**, Preprint 26, 16 pp. (1945).

The recent literature on copper plating is reviewed and particular emphasis is placed on the development of the ideas which have led to the modern high efficiency-high current density processes. Factors which appear to be most significant in influencing the physical nature of the deposit are (a) type of solution, e.g. acid, cyanide, pyrophosphate, (b) current density, (c) temperature, (d) degrees of agitation and (e) nature and concentration of addition agents.

LEONARD E. WEEG

Performance and Structure of Anodic Coatings on Aluminum

F. KELLER and J. D. EDWARDS. *Iron Age* **156**, No. 21, 75 (1945).

The service life of anodic coatings on aluminum can be controlled by choice of production procedures and conditions. The structures of various anodic coatings on different aluminum alloys are shown in numerous photomicrographs. The transparency of oxide coatings on pure aluminum is shown by means of specially prepared samples wherein the aluminum was ground off, leaving the anodic coating mounted in lucite. Alloy constitutents render the coating less transparent and more porous.

C. W. SMITH

Fusion Brightening of Electro-Tinplate

ANON. *Iron Age* **156**, No. 16, 57 (1945).

H. J. Francis of Armour Research Foundation of the Illinois Institute of Technology has developed a technic permitting microscopic examination of tinplate during fusion. Attachement of a motion picture camera to the microscope makes it possible to record the entire cycle.

The initial fusion is followed by de-wetting when temperature is carried too high or maintained too long before quenching. This is shown graphically in four separate photographs.

C. W. SMITH

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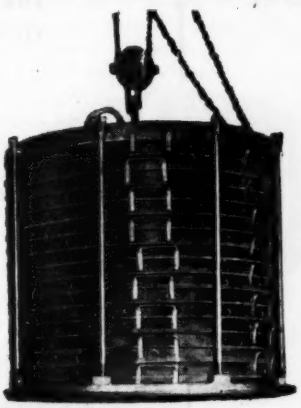

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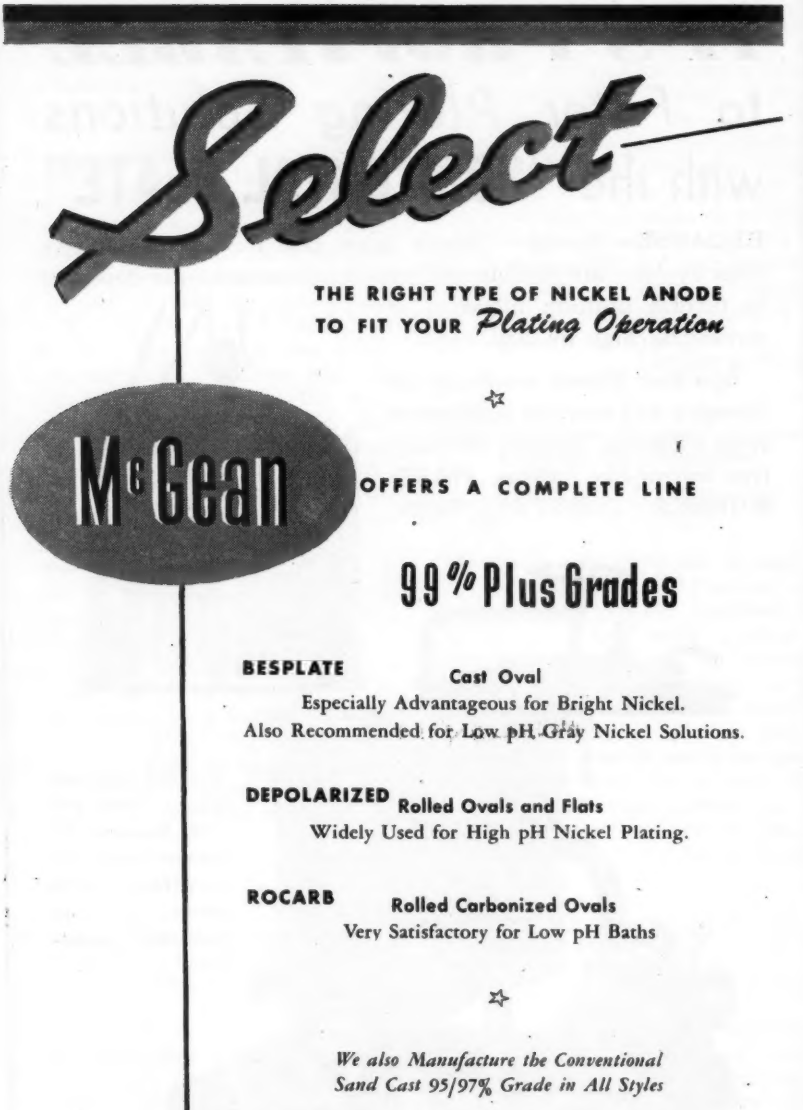
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Metal Finishes and Finishing Processes IV

EDWARD ENGEL. *Iron Age* **156**, No. 13, 65 (1945).

In this final section valuable information is included under the following table headings: Comparative data, Army and Navy Specifications, Lacquers and Enamels; Comparison of Convection and Radiant Drying Time on a Few Specific Synthetic Lacquers; Comparative Drying Time of Colored Lacquers Using Infra Red Lamps; Tinting and Hiding Power of White Pigments; Luminescent Coatings; Preservatives (Rust Preventives); Metal Surface Testing Equipment and Procedures.

C. W. SMITH

Chromate Deposits — Effect of pH Value and Time of Immersion

S. G. HOWDEN-SIMPSON. *Metal Industry* (England) **67**, 258-61 (1945).

A study was made of a chromate bath for magnesium (British Patent Nos. 331,853 and 353451) containing 1.5% potassium dichromate, 3.0% ammonium sulphate, 1.5% ammonium dichromate, and 0.5% ammonia (sp. gr. 0.880).

Salt spray tests and microscopic examination indicated the optimum conditions to be: pH — 6.0, time — 10 minutes, temperature — boiling. The coatings are thin but less porous than heavier coatings.

L. M. MORSE

Chlornaphthalene Wax — Advantages and Limitations for Stopping-Off

C. W. RICHARDS. *Metal Industry* (England) **67**, 266-68 (1945).

The ideal stopping-off material is one with good dielectric properties, adhesion, resistance to cleaning and plating solutions, ease of application and removal, capacity for use at elevated temperatures, ease of recovery and non-toxicity. Chlornaphthalene wax, a chlorinated naphthalene, meets most of the requirements. The softening point of the wax depends upon the degree of chlorination. The pure, unplasticized wax is rather brittle.

The best technique is as follows: (1) Use a wax having a softening point of approximately 120°C and maintain the molten wax at about 140°C with adequate provisions for ventilation; (2) Heat articles to be treated in degreaser vapor to 80°C, and immerse in the molten wax until the metal reaches the temperature of the wax, then remove; (3) Cool in a ventilated cupboard; (4) Re-dip as many times as necessary; (5) After plating, melt off most of the wax in a wax pot and remove the remainder in a degreaser.

The one disadvantage of the chlornaphthalene type wax is its toxicity. Adequate ventilation of all melting and cooling stations is a necessity and absolute cleanliness of shop and personnel is important. Persons with tendencies toward liver disorders, jaundice, or acne should not be employed in the vicinity of the wax.

L. M. MORSE

Surface Preparation with Abrasive Belts

E. A. OATHOUT. *Products Finishing* **10**, No. 2, 54-62 (1945).

Surface preparation of metals with coated abrasive belts vs. setup wheels and the effectiveness of the idler back stand principle are shown. Various types of idler back stands are described.

RAYMOND F. LEDFORD

Racking — Plating Fixtures for Specialized Purposes

S. L. VAUGHAN and I. A. USHER. *Metal Industry* (England) **67**, 170-2 (1945).

The factors to be considered in rack design are discussed. Descriptions and drawings are given for a number of plating racks developed and used in the author's plant for hard chromium plating, including the plating of a gun barrel. When large surface plates are plated, "baffle" anodes were used to eliminate effects of the anode gases circulating against the surface. The baffles were tilted to make anode. The use of cathode agitation is mentioned in connection with the plating of drills, reamers and milling cutters.

L. M. MORSE

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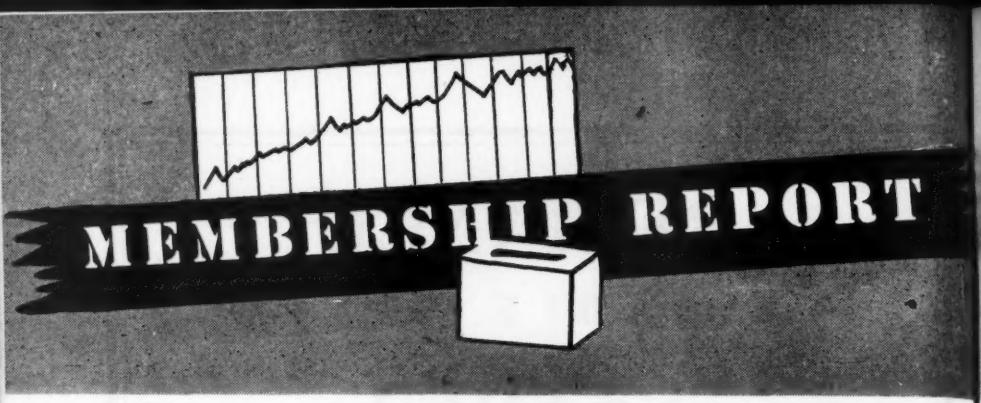

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Melbourne Branch President Visits United States

MR. MAURIE ANDREWS, President of the Melbourne Branch, arrived in New York on January 16. His ship was delayed several days by heavy storms and it took some little time before Messrs. Horace Smith and George Wagner of the Newark Branch, his reception committee, succeeded in making contact with him. He plans to stay in this country until March 4 when he will leave for Australia from San Francisco. On his way he stopped in South Africa and spent not less than six weeks in England enroute to this country. The prime purpose of his trip is to study developments in electroplating and other finishing mehtods which have taken place during the war. For this purpose he has spent considerable time in New York and New Jersey and plans to visit the Detroit, Chicago and Los Angeles areas.

Mr. Andrews is the Managing Director of The Nella Enamelling & Electroplating Co. Pty. Ltd. of South Yarra, Melbourne, one of the biggest job shops in Australia which, prior to the war, employed not less than 130 people. He is also a member of the Council of the Collingwood Technical School in Melbourne which gives day and night courses in electroplating and has a complete plating plant for the use of its students. He represents the Victorian Electroplaters' Association on which the Melbourne Branch is represented.

We are very happy over the visit of Mr. Andrews because, for the first time, we have had an opportunity to learn about the activities of the Melbourne Branch. Apparently correspondence from this Branch has been misdirected and never reached the Executive Secretary's office. Mr. Andrews informs us that the Branch now has about 80 members and is looking forward to reaching a membership of at least 200. The Branch has been very active since it was granted a temporary charter, has held well attended regular meetings at the Chamber of Manufacturers Building, Flanders Street, Melbourne, with lectures on electroplating subjects by members. Separate monthly lectures on Elementary Chemistry of Electroplating are given at Melbourne University. Mr. Andrews expressed the hope that his Branch will soon be granted the regular charter applied for to permit it to participate more actively in the affairs of the A.E.S.

We wish Mr. Andrews a successful visit in the U. S. and an uneventful return trip to Australia. He will, on his return, carry greetings from the Society's members to the Sydney and Adelaide Branches as well as to the Melbourne Branch.

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MEMBERSHIP CHART

BRANCH	May 1945	Change in Membership	Percent Change
FIRST GROUP			
LOS ANGELES	151	+18½	+12.2
CLEVELAND	143	+16½	+11.5
PHILADELPHIA	154	+13	+ 8.4
DETROIT	390	+30	+ 7.7
WATERBURY	122	+ 8	+ 6.6
CHICAGO	357	+23	+ 6.3
NEWARK	213	+13	+ 6.1
NEW YORK	191	+10½	+ 5.5
BOSTON	157	+ 8	+ 5.1
BALTIMORE-WASH.	122	+ 5½	+ 4.5
HARTFORD	126	+ 2½	+ 2.0
GRAND RAPIDS	121	+ 1	+ 0.8
SECOND GROUP			
PITTSBURGH	80	+ 7½	+ 9.4
PROV.-ATTLEBORO	101	+ 8½	+ 8.4
TORONTO	119	+ 8	+ 6.7
MILWAUKEE	107	+ 6	+ 5.6
BRIDGEPORT	118	+ 6½	+ 5.5
ROCHESTER	90	+ 4	+ 4.4
INDIANAPOLIS	112	+ 1	+ 0.9
SPRINGFIELD	73	+ ½	+ 0.7
ST. LOUIS	116	+ ½	+ 0.4
NEW HAVEN	106	— ½	— 0.5
DAYTON	109	— 3	— 2.7
BUFFALO	89	— 4½	— 5.1
THIRD GROUP			
ROCKFORD	23	+15	+65.2
SYDNEY	51	+31	+60.8
TWIN CITY	52	+14	+26.9
SAN FRANCISCO	55	+13	+23.6
SYRACUSE	57	+ 7	+12.3
JACKSON-LANSING	62	+ 7½	+12.1
TOLEDO	54	+ 4½	+ 8.3
LANCASTER	39	+ 2½	+ 6.4
CINCINNATI	57	+ ½	+ 0.9
MONTREAL	54	— 1½	— 2.8

Membership May 1, 1945 = 3972 | Gain in Membership = 308
Membership Feb. 1, 1946 = 4300 | Per Cent of Gain = 8.2

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TOLEDO BRANCH

The December 6 meeting held in the office of the Vic. Miner Co. was opened at 9 p.m. After some discussion the secretary was instructed to act as a delegate and to vote for the Newark amendment.

It was suggested that the libraries of Toledo University or Bluffton College be contacted in an effort to establish subscriptions to the MONTHLY REVIEW.

The January 16 Educational Session in Chicago devoted to a Symposium on Nickel Plating was announced. The Grand Rapids Branch extended an invitation to its Educational Session and Dinner Dance.

Mr. Charles Eldridge of United Chromium, Inc. spoke about "Rack Coatings".

GASTON BERGEMAN, *Secretary*

HARTFORD BRANCH

The Weather Man frowned on the city the evening of December 10 and only 25 hardy souls ventured out to hear Meyer Shacat of United Chromium, Inc. talk on "Bright Copper" in the Egyptian Room of the Hotel Bond. Mr. Shacat covered his subject thoroughly and gave a clear picture of the equipment and materials necessary for the installation of his company's copper plating process. He discussed in detail the technical aspects of the operation of the process. At the conclusion of the talk a display of parts plated with "Unichrome" high speed copper were exhibited. After answering many questions from the floor Mr. Shacat was given a rising vote of thanks for a well delivered talk.

FRANK W. SMITH, *Secretary*

SYRACUSE BRANCH

At the meeting November 16, Mr. Robert Sizelove outlined the activities of the Research Committee and discussed the quota of Sustaining Memberships assigned to the Syracuse Branch and its importance in raising funds for the Research Projects.

Dr. Clinton W. MacMullen presented an excellent paper on "Wetting Agents" which was followed by a discussion period.

NEIL MAFFEI, *Secretary*

SYRACUSE BRANCH

President Dr. Murphy announced the appointment of Paul Swartz to serve as co-chairman of the Branch Research Committee at the meeting on December 14.

Copies of the Newark Branch Yearbook were passed out and gratefully received.

Mr. Frank K. Rouge of The Electric Products Company read a paper entitled "More for Less", in which he discussed the performance characteristics and the economics of generators vs. rectifiers.

NEIL MAFFEI, *Secretary*

WATERBURY BRANCH

Plans for the Regional Meeting will be initiated at the business meeting to be held on January 4 at the home of Ellsworth Candee, it was announced at the December 14 meeting.

Technical Chairman Joe Thompson introduced Jack Hyner in his regular book review. His book of the month, "Engineering Alloys" by Woldman and Meltzler, published by the American Society for Metals, is a compendium of the properties and some of the uses of alloys produced both here and abroad.

Henry Strow discussed as a new development the plating of Speculum metal, an alloy of tin and copper. It is deposited from a cyanide solution and among other desirable properties has good adherence and ductility.

The movie for the evening "Magnesium, Metal from the Sea", supplied through the courtesy of the Bureau of Mines, pictured very completely the production and fabrication of this useful light metal.

Mr. L. C. Conradi of the Standard Steel Spring Company, Coraopolis, Pa., gave a

very interesting talk on "The Corronizing Process" and showed numerous samples. Two types of coating are produced, a nickel-zinc and a nickel-tin alloy. The nickel-zinc combination gives the highest corrosion resistance. The nickel-tin coating is brighter and useful particularly in the food industry.

S. L. HENN, *Secretary*

SYDNEY BRANCH

At the November meeting the following were elected to office for the year 1946: President, Leo Phelan; First Vice President, Ernest J. Wright; Second Vice President, H. George Harvey; Secretary-Treasurer, Charles Freeman; Librarian, Frank Heard; Board of Managers: Benjamin Armstrong, Glen S. R. Walker and Fred Bellenger.

LAWRENCE SMITH, *Secretary*

ST. JOSEPH VALLEY BRANCH

The dinner which preceded the meeting on October 3 at Hotel Elkhart, Elkhart, Indiana was attended by approximately sixty persons. An additional number attended the technical session.

Several visitors from other Branches were introduced. A number of petitions for membership were presented. All being found in good order were voted upon and accepted.

Librarian Wysong introduced Mr. B. F. Lewis, Technical Director of the Northwest Chemical Company of Detroit, who spoke on "Metal Cleaning and Adhesion". He covered the field of cleaning from the original surface up to the actual action of plating, and brought out methods and procedures which must be followed in order that good adhesion be obtained, as well as many reasons for lack of adhesion. Mr. Lewis then kindly took part in the question box discussion.

GEORGE A. BOCK, JR., *Secretary*

ST. JOSEPH VALLEY BRANCH

The November 7 meeting was held in the Empire Room of Hotel Elkhart. Forty-six members and guests attended the dinner. President John Lockerbis introduced a number of visitors from other chapters.

Three applications for membership were voted upon and accepted.

Acting Librarian Fred Craven introduced Mr. R. S. Modjeska, Director of the Scientific Control Laboratories, Chicago, Ill. Mr. Modjeska gave a talk on "Filtration in the Plating Industry" in which he explained the use of filterbestos, activated carbon and filter aids. The question and answer period which followed brought forth considerable discussion. Messrs. Wurster and Fuller of Industrial Filter and Pump Manufacturing Company, Chicago, Ill. then demonstrated the action of a filter unit with a glass model.

GEORGE A. BOCK, JR., *Secretary*

PITTSBURGH BRANCH

Miss Morrison and Mr. Stockton of Standard Steel Spring Company presented a talk on the "Cleaning and Electroplating of High Carbon Steel" at the December 20 meeting at the Roosevelt Hotel.

FRANK R. KELLER, *Secretary*

CHICAGO BRANCH

The January 11 meeting was held at the Hamilton Hotel, President P. Krause presiding.

A request by C. G. Conn Ltd. for permission to make a wire recording of the Regional Meeting was granted. A copy of this recording will be mineographed and sent to the MONTHLY REVIEW and the members of the Chicago Branch.

E. H. Lyons, Jr., Second Vice President of the Branch, entertained with his colored motion pictures of Utah and Colorado. The pictures covered about a month of bus, train, horse and foot travel in the West with its canyons, mountains, high peaks, beautiful flowers and fruit. Mr. Lyons had visited districts that were rough and almost unexplored by man. He explained the pictures and told stories for two enjoyable hours.

The following questions were discussed:

Q. 1: What is a good stripping method for the removal of nickel from die castings? — A. Reverse current in 60° Bé sulphuric acid at 80°F.

Q. 2: How can one produce a bright surface on a dirty zinc base die casting without plating? — A. With the Zinc Chrome Process, polishing or barrel finishing.

M. H. LONGFIELD, *Secretary*

MILWAUKEE BRANCH

Mr. Vincent Mattacotti was appointed chairman of the Branch Papers Committee for the 1946 convention at the 363rd regular meeting on December 7.

Following the election of new members, Mr. W. A. Helbig of the Darco Corporation gave some very interesting information on the action of activated carbon in filtering plating solutions. The ability of carbon to remove only definite amounts of one organic substance while it retains the ability to remove others is one characteristic most of us did not know. For example, it may be saturated with wetting agents and brighteners and still continue to remove oils and other organics.

After Mr. Helbig's talk and demonstration with a glass filter, Phil Ritzenthaler gave a very informative résumé of the article on "Adhesion of Electrodeposits" in the November issue of the REVIEW.

JAMES DURNFORD, *Secretary*

MILWAUKEE BRANCH

The 364th regular meeting was held on January 4. The new year saw the Milwaukee Branch off to a fine start with a large turnout to hear Mr. O. Kocour speak on "Instruments for Solution Control and Thickness Testing". His display included pH instruments, standard solutions, Magne-Gages, the Hull Cell, and many others. Beer and pretzels were served. Since none of the members in Milwaukee care for such refreshments they went untouched.

JAMES DURNFORD, *Secretary*

TWIN CITY BRANCH

Thirty-nine were present at the January 7 meeting. President Paul Felt introduced the following guests: John J. Harrington of Northwest Airlines, A. J. Fisher of Universal Plating Company, Howard J. Hawkins of Hawkins Chemical Company and Mr. Aske of Solventol Chemical Co.

The door prizes, leather cases containing playing card sets, were donated by Brown and Bigelow. The recipients were E. W. Presser and E. R. Frost.

E. H. Lindemann gave a report for the Research Fund Committee and announced that while the Branch had met its quota there were several concerns that had not yet had the time to consider the advantages. Gunnar Deedon advised that his committee is working on the Convention Exhibit and would give more definite information at the February meeting.

Mr. E. R. Kraft of Rheem Research Products spoke on "Chromate Finishes" and presented the operating characteristics and conditions for various processes.

ROBERT L. BUCKLEY, *Sec'y-Treasurer*

CLEVELAND BRANCH

The regular monthly meeting was held January 4, with George Svenson in the chair.

Librarian Ralph Schaefer introduced the speaker of the evening, Mr. W. S. Morrison of the Illinois Water Treatment Company. His subject was "An Exchange Method for Water Treatment". The talk was very interesting and brought forth many questions.

Three new members were elected.

HARVEY P. HEIL, *Sec'y-Treasurer*

NEWARK BRANCH

Forty-seven members attended the December 7 meeting presided over by First Vice President John DeVries.

Six Branches had acknowledged receipt of the Newark Branch Year Book. Howard L. Cobb was elected to survey the field for Convention papers.

There were three elections of new members, one reinstatement and three applications for membership.

Our own member, Robert S. Herwig, Research Chemist with the Bendix Aviation Corporation, Teterboro, N. J., gave a well received paper on "Black Anodic Coatings on Aluminum Alloys" which will be published in a forthcoming issue of the REVIEW.

GEORGE WAGNER, *Secretary*

NEWARK BRANCH

Seventy-three members and guests attended the January 4 meeting. Three additional branches had expressed their thanks for the Year Book and several requests, among them from the French Re-

public, for additional copies were complied with. Dr. A. K. Graham, in a communication, advised that the Newark Branch Amendment had carried by a twenty-six to one vote. Two applications for membership were received.

Mr. Clifford Struyk of the Wright Aeronautical Corp., Paterson, N. J., a member of the Newark Branch, spoke on "Tin-Bronze Alloy Plating". He stated that this deposit was the only successful substitute for a tin deposit as a stop-off in the hardening of airplane parts, and that it was also useful for decorative purposes. Finished samples were exhibited. An interesting discussion followed.

Librarian Howard L. Cobb then conducted the Question Box.

GEORGE WAGNER, *Secretary*

BRIDGEPORT BRANCH

Arthur R. McNeil, member of the Technical Sessions Committee, presided at the Open Meeting and Educational Session on December 14 at which forty-two members and guests were present.

Mr. F. J. Kalafus, Contract and Office Manager of the Contract Plating Co., Stratford, Conn. and a member of this Branch, spoke for Mr. R. J. O'Connor, Second Vice President of A.E.S., President of the Contract Plating Co. and also a member of the Branch, who was unable to present his talk because of illness. Mr. Kalafus, who has wide experience with the subject "Costs, Job Evaluation and Bonus Incentives", gave an excellent presentation which led to a lively discussion.

J. G. STERLING, *Sec'y-Treasurer*

BRIDGEPORT BRANCH

Forty-one members and guests were present at the December 7 meeting.

C. C. Helmle, Chairman of the Branch Research Committee announced the appointment of V. Consalvo and R. J. Kwasnik as members of the Committee.

The members expressed their regret and deep sympathy to Mr. and Mrs. Louis Shamas in the loss of their child.

Ed Loeffel has been honorably discharged from the Armed Forces.

A letter from F. J. MacStoker, Secretary-Treasurer of the New York Branch invited the members to their regular and open New York meetings.

In response to a letter from Frank K. Savage, First Vice President of A.E.S., strongly suggesting that a committee be appointed to secure papers for the Educational Sessions at the National Meeting in Pittsburgh, the Branch elected Dr. Walter R. Meyer to be Chairman of a Branch Papers Committee.

The Secretary was ordered to purchase a five dollar Christmas Seal Bond from the "Visiting Nurse Association of Bridgeport".

There were two applications, two elections and one suspension for non-payment of dues.

President H. C. Braun appointed William A. Ehrencrona Chairman of a Committee to take care of the annual "Old Timers' Night".

Librarian C. C. Helmle asked William A. Ehrencrona and H. M. Goldman to talk on chromium plating. Both then gave valuable information drawn from their wide experiences.

J. G. STERLING, *Sec'y-Treasurer*

MONTREAL BRANCH

Fifteen members were present at the January 14 meeting. There was one resignation and three suspensions for non-payment of dues.

P. R. Davidson then conducted a discussion of the paper by Dr. Walter Meyer entitled "The Effects of Impurities in Plating Solutions".

WILLIAM L. F. GLOVER, *Sec'y-Treasurer*

NEW HAVEN BRANCH

The November 13 meeting opened with the showing of an informative film "Lead Milling, Smelting and Refining".

Meeting Chairman Joseph Downes presented Mr. R. J. O'Connor, President of Contract Plating Co. and Second Vice President of A.E.S. His thorough familarity with the timely subject "Metal Finishing Costs" gave the members a very fine educational evening. The talk included discussions of job evaluation and bonus incentives in still plating, barrel plating, and lacquer finishing.

B. J. GAFFNEY, *Secretary*

EDUCATIONAL MEETINGS ANNOUNCED

NEW YORK BRANCH

The Afternoon Technical Session of this meeting will be held in the Keystone Room of the Hotel Pennsylvania, Seventh Avenue and 33rd St., New York City, Saturday, February 23, at 3:00 P.M.

The following program is scheduled:

"Practical Brass Plating"
Mr. William J. Schneider
E. I. du Pont de Nemours Co.

"New Developments in Silver Plating"
Mr. Philip Lo Presti
Sylvania Electronics Corp.

"Polishing and Grinding of Metals"
Mr. Howard McAleer
Formax Mfg. Co.

The session will be followed by a "Victory Celebration" Banquet entertainment and dance, commencing at 7:30 P.M. in the new Manhattan Room. A good dinner, swell show, and top ranking orchestra are promised — as well as numerous door prizes. Reservations are $7.50 per person and should be addressed to Franklyn J. Mac Stoker, General Chairman, 25 Princeton St., Garden City, N. Y.

BOSTON BRANCH

The Eleventh Annual Technical Session and Banquet of the Boston Branch of the American Electroplaters' Society will be held in the Main Ballroom of the Hotel Statler on Saturday, March 9, 1946. This, our first post-war affair, should prove to be unusually enjoyable socially; and, from a technical standpoint, especially valuable to all of us in our reconversion problems.

Leonard Chesworth, Chairman of the Educational Committee, has lined up an exceptional technical session, which will include the following speakers and subjects:

L. C. Conradi — "Corronizing"

Walter Pinner — "High Chloride Nickel Plating"

William C. Phillips — 'Subject to be announced"

This session will get under way at 1:30 P.M. with Dr. Walter Meyer presiding. We are looking forward to interesting discussions.

Mrs. Ann Baker Love, who has done such a marvelous job in previous years, has arranged a program for the ladies which will provide a most enjoyable and entertaining afternoon.

The Banquet program includes an excellent dinner, door prizes, a gala floor show, and dancing until midnight.

The tickets at $5.00 each, include tax and gratuities to waiters. Remember the date—Saturday, March 9. See you then.

JOSEPH T. SULLIVAN, *Publicity Chairman*
LOUIS GAGNON, Chairman

BRANCH NEWS

NEW HAVEN BRANCH

The December 11 meeting opened with the showing of the film "Alloy Steels".

President Walter T. Lynch appointed the following Committees: *Membership:* Joseph M. Cooke (Chairman), William G. Yokel, Clarence Garner, William A. Montgomery and John M. Barry. — *Research:* C. Fred Gurnham (Chairman), George G. Knecht, Bernard J. Gaffney, Albert Rosenthal and George A. Tracchio. — *Exhibit:* Clarence Garner (Chairman), Henry J. Creamer, Joseph L. Downes, Richard Johnson and Joseph Sexton. — *Sick:* John W. English (Chairman), William F. Bridgett and Robert E. Mooney.

Meeting Chairman Henry B. Smith presented Mr. Myron B. Diggin, Chief Chemist, Hanson-Van Winkle-Munning Co. His subject was "The Removal of Impurities from Electroplating Solutions", an important problem which has caused many worries to the plating industry. Mr. Diggin spoke of each solution individually and illustrated his talk with lantern slides.

B. J. GAFFNEY, *Secretary*

SAN FRANCISCO BRANCH

An excellent floor show and dancing to a splendid orchestra was enjoyed by the forty persons who attended the Annual Christmas Party at the Club Lido on December 8. Not less than fourteen door prizes had been contributed by supply houses and plating companies at this successful affair.

J. R. PATTENGER, *Sec'y-Treasurer*

SAN FRANCISCO BRANCH

A dinner attended by sixteen persons preceded the January 10 meeting. There were two elections to membership.

Mr. J. C. Brossart, Industrial Filter & Pump Mfg. Co., Chicago, Ill., presented an excellent paper on "Modern Technique in Filtering Electroplating Solutions" and answered many questions from the appreciative audience.

J. R. PATTENGER, *Sec'y-Treasurer*

BOSTON BRANCH

There were one election to membership, one reinstatement and three applications at the January 3 meeting.

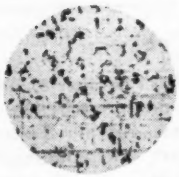
The Banquet Committee reported an Educational Session in the afternoon and a Banquet and Floor Show in the evening of March 9. Ann Baker Love will entertain the ladies.

Acting Librarian Louis V. Gagnon then presented Messrs. Kenneth M. Huston and John Kreml of the Rustless Iron & Steel Co., Baltimore, Md. Mr. Huston, being the Third Vice President of A.E.S., began by describing the work of the Research Committee and asked for the Branch support. He then read a paper on "Electrolytic Polishing of Stainless Steel", after which Mr. Kreml demonstrated the process with a small electropolishing unit, passed samples around to the members and answered questions put from the floor.

A. W. GARRETT, *Sec'y-Treasurer*

Siebold Takes Over Broadston Litho Supply Corp.

J. H. & G. B. Siebold, Inc., 47 Watts St., New York, N. Y. announces acquisition of Broadston Litho Supply Corp. of 55 Vandam St., New York, N. Y.



Typical one-bath process. Poor color and density. Insufficient protection and sharp edges.

Two baths produce dense color, superior rust protection, equalized grain, reduced friction.

Microphotographs taken on identical steel surfaces by an impartial laboratory.

Finish the Job Right with PENTRATE

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The only patented 2-BATH Process
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Pentrate offers permanent solution stability in a black finish for steel. This two-bath process is patented.

For certain alloy steels Pentrate is the *only* process that will guarantee proper and uniform blackening. For all steels it furnishes a better finish in a shorter time.

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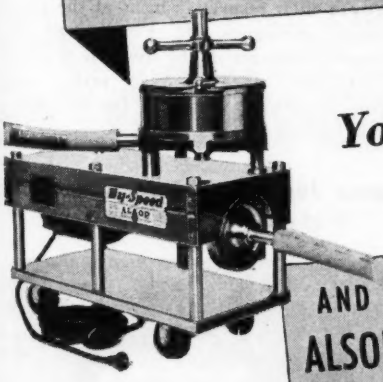
DO IT FASTER!

We mean all Your electroplating work



AND CUT PRODUCTION COSTS WITH ALSOP'S New "Sealed-Disc" Filters

Yes, faster but with perfect filtration of your plating solutions . . . elimination of rejects caused by dirty solution . . . superior plating coming from the plating baths.

This means reduction in production costs!

The "Sealed-Disc" filter is designed to meet plating room requirements. It is extremely compact, requiring very little floor space considering its remarkable filtering speed and volume, and is easy to clean even when changing from one solution to another. One user in your field sums it up pretty well as follows:

"We might say that the output of such a small filter is really amazing to us. We have been so used in the past to using filters requiring much larger floor space to get anything like the output that your small, compact unit gives. We believe it cleverly designed."

You can have the same positive, trouble-free plating. Just write us for more details; there's no obligation.

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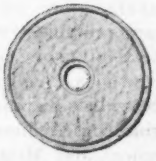


This scientifically designed filter disc, the basic element of the Alsop filters, enables you to control the quality of your solution. The unique construction stops increasingly finer particles as they penetrate the disc. The final result is a perfectly clarified solution, free from all foreign matter and cloudiness, a faster, more economical filtration. Eight different disc densities make available any degree of filtration you may require.

We can supply this filter material cut in any shape and size to fit other type filters.

Available for inspection at our booth at the Chemical Show—Nos. 321-322.

INDUSTRY NEWS

Foreman Plater Polisher and Buffer Wanted

Mid-West concern making electric appliances wants foreman who understands full automatic nickel and chrome plate; also capable of taking over polishing and buffing, latest automatic equipment. Reply stating experience and salary expected. MR-2B, MONTHLY REVIEW, P.O. Box 168, Jenkintown, Pa.

Plater Chemist Available

Former Navy man with ten years' experience in practical plating work and solution control desires position in Philadelphia area. Three year Navy experience included setting up and operating plating platn here and abroad. Evening school graduate in electroplating chemistry. Age 28, married, conscientious, very willing and able to work. MR-2A, P.O. Box 168, Jenkintown, Pa.

Plating Firms Prominent on List of Prime Contractors Honored for Atomic Bomb Work

Plating firms and manufacturers with large plating operations are prominent on the list of the 115 prime contractors for the Atomic Bomb Project who are collectively receiving the Seventh Biennial Award for Chemical Engineering Achievement presented by "Chemical and Metallurgical Engineering". The award will be made on the evening of February 26th at a banquet to be held at the Waldorf-Astoria in New York. Reproducing this list would require much more space than is available but more pertinent details of the award may be reported in the next issue since other A.E.S. members, in addition to President Pinner, may have been appointed to represent their respective firms at the presentation ceremonies. Mr. Pinner was the Technical Manager of the division of Houdaille-Hershey engaged as a prime contractor to make a vital part for the Manhattan District Project.

Mazia Joins American Chemical Paint

The American Chemical Paint Company, Ambler, Pa. announces the addition of Joseph Mazia to its staff. Mr. Mazia, as metallurgist in the Metal Surface Treatment Division of the company, will specialize on research and development of new corrosion prevention methods and with commercial application of A.C.P.'s Granodine and Deoxidine processes.

Previously Mr. Mazia headed the Protective Finishes Section of the Ordnance Research Laboratory, Frankford Arsenal where he served a five-year tour of duty. He is an active member of the Philadelphia Branch, A.E.S., and active in committee work of A.S.T.M. (Comm. B-8) and A.S.M., on electrodeposited coatings, organic finishes and corrosion testing.

Prior to his Government service he worked as metallurgist for A. Mazia and Son, Inc., Philadelphia, Pa., specializing in precious metals, fabrication and plating.

A graduate of the University of Pennsylvania, Class of 1935, Mr. Mazia continued with post-graduate studies in metallurgy and related sciences at Colorado School of Mines, Temple University and University of Pennsylvania Graduate School.

H-VW-M Adds to Staff

A number of changes in the staff and field forces of the Hanson-Van Winkle-Munning Company, Matawan, N. J., have been announced. These changes include the return of several of their staff from the Armed Forces and also the addition of new people.

John A. Bauer has been appointed Sales Manager of the Company. Mr. Bauer has been with the Company almost twenty years, coming from A. P. Munning and Company, which he had joined in 1926 as Advertising Manager. He took the same post with H-VW-M in 1927 after the merger of A. P. Munning and Company and

JOHN A. BAUER

FOR SALE **Available for Immediate Shipment**

1—7500/3750 AMPERE, 6/12 VOLT, **A. P. MUNNING CO.** "OPTIMUS" Design, Motor Generator Set. Separately Excited. Excellent Condition. Full Controlling Equipment.

1—2500/1250 AMPERE, 12/24 VOLT, **CHARLES J. BOGUE ELECTRIC CO.** Motor Generator Set. Separately Excited. Excellent Condition. Full Controlling Equipment.

1—1500/750 AMPERE, 6/12 VOLT, **HANSON & VAN WINKLE CO.** (INTERPOLE) TYPE, Motor Generator Set. Excellent Condition throughout. Full Controlling Equipment.

1—1500/750 AMPERE, 6/12 VOLT, IMPROVED **AMERICAN GIANT** Motor Generator Set. Complete Controlling Equipment. Excellent Condition.

10—1440/720 AMPERE, 6/12 VOLT, **UDYLITE (MALLORY) RECTIFIERS.** Input Rating: 220/440 volts, 3 phase, 60 cycles. Excellent Condition.

2—750/375 AMPERE, 6/12 VOLT, **HANSON & VAN WINKLE CO.** Motor Generator Sets. Excellent Condition. Full Controlling Equipment.

15—125 AMPERE, 7½ VOLT, **HOBART BROTHERS CO.** Motor Generator Sets. Like New. Full Controlling Equipment.

ANODIZING MOTOR GENERATOR SETS

1—1000 AMPERE, 50 VOLT, **CHANDEYSSON ELECTRIC CO.** SYNCHRONOUS-DRIVEN Motor Generator Set, complete with Exciter and Full Controlling Equipment.

1—500 AMPERE, 60 VOLT, **WESTINGHOUSE** Motor Generator Set, complete with Full Controlling Equipment.

2—500 AMPERE, 40 VOLT, **MOTOR GENERATOR CORPORATION** Motor Generator Sets. Excellent Condition. Full Controlling Equipment.

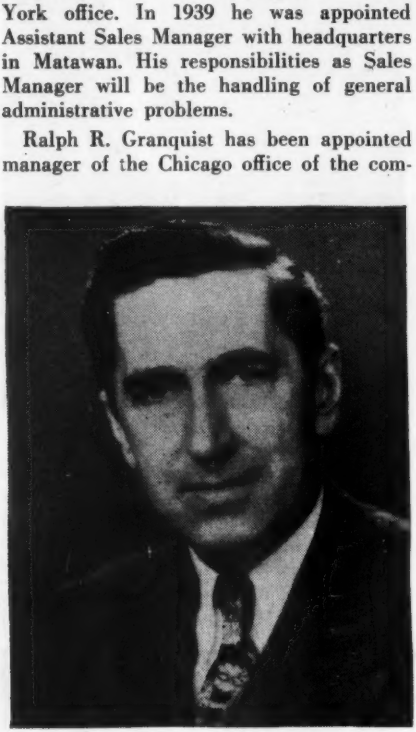
2—400 AMPERE, 40 VOLT, **MOTOR GENERATOR CORPORATION** Motor Generator Sets. Complete with Full Controlling Equipment.

1—500 AMPERE, 24 VOLT, **HANSON & VAN WINKLE CO.** INTERPOLE TYPE Motor Generator Set. Excellent Condition, Full Controlling Equipment.

M. E. BAKER COMPANY 143 SIDNEY STREET CAMBRIDGE, MASS.

the Hanson and Van Winkle Company. In 1933, Mr. Bauer took charge of the Pittsburgh office; from 1934 to 1936 he managed the Philadelphia office, and from 1936 to 1939 he was in charge of the New York office. In 1939 he was appointed Assistant Sales Manager with headquarters in Matawan. His responsibilities as Sales Manager will be the handling of general administrative problems.

Ralph R. Granquist has been appointed manager of the Chicago office of the com-

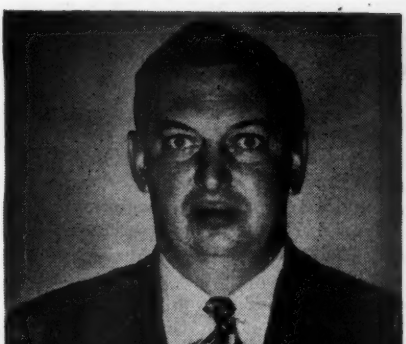


RALPH R. GRANQUIST

pany. Following his graduation from college, Mr. Granquist engaged in other fields for a time and entered the employ of Hanson and Van Winkle Company in 1923. He has been a field representative, located in the Chicago office since that time, and is widely known in this territory.

Harold R. Smallman, who also maintains his headquarters in the Chicago office, remains as Western Manager.

William J. Wise, formerly a field representative of the company and more recently a lieutenant in the U. S. Navy, has rejoined the company. Mr. Wise is a graduate of the University of Dayton in Chemical Engineering. He spent nine years with the National Cash Register Company and joined H-VW-M in 1940. In 1942 he entered the service of Uncle Sam in the



WILLIAM J. WISE

Navy, became Aviation Ordnance Officer on the carrier "Bataan" and later Ordnance officer of CASU 22. Mr. Wise will make his headquarters in Dayton, Ohio.

"YANKEE BRAND"

PROGRESSIVELY BETTER ABRASIVE COMPOUNDS

Tailored to fit all finishing requirements.

Inquiries respectfully solicited

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ASTM Spring Meeting in Pittsburgh Features Symposium on Corrosion of Non-Ferrous Metals and Alloys and Discussion on Statistical Quality Control

The two technical features of the Spring Meeting of the American Society for Testing Materials (ASTM) being held at the Hotel William Penn in Pittsburgh, February 26 and 27 involve several papers relating to statistical quality control and its relation to specifications and the Symposium on Atmospheric Exposure Tests of Non-Ferrous Metals and Alloys.

Under Society auspices, primarily through the work of its Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys, there have been many thousands of test specimens of various metals on exposure in sites from coast to coast, some of these specimens having been on the racks for over ten years. This symposium is intended to correlate the vast amount of data developed and the speakers, each an authority in his field, will bring out pertinent aspects of the data which it is believed will make the information of most service to the companies and individuals concerned with this vital subject.

The program follows:

"The Corrosion of Rolled Zinc in the Outdoor Atmosphere" — E. A. Anderson, Chief of the Metals Section, Research Div., The New Jersey Zinc Co.

"The Behavior of Nickel and Monel in Outdoor Atmospheres" — W. A. Wesley, Ass't. Director, Research Lab., The International Nickel Co., Inc.

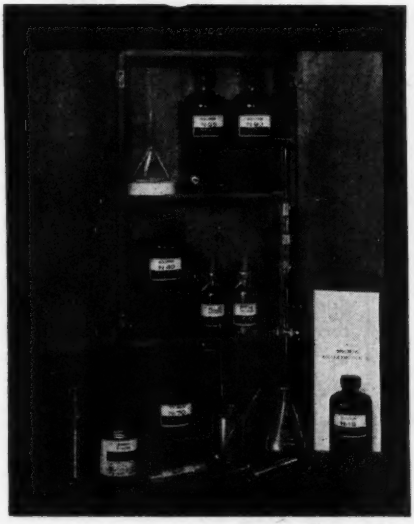
"Resistance of Copper Alloys to Atmospheric Corrosion" — A. W. Tracy, Ass't. Metallurgist, The American Brass Co.

"Use of Lead and Tin Outdoors" — G. O. Hiers, Chemist, Research Labs., National Lead Co.

"The Resistance of Aluminum Base Alloys to Atmospheric Exposure" — E. H. Dix, Ass't. Director, Research and Chief Metallurgist, and R. B. Mears, Chief, Chemical and Metallurgy Div., Aluminum Research Labs., Aluminum Company of America.

W. H. Finkeldey, Singmaster & Breyer, Chairman of Sub VI on Atmospheric Corrosion, Committee B-3, has been arranging the symposium. J. J. Bowman, Aluminum Company of America, is cooperating for the Pittsburgh District.

This symposium will be held in two sessions on the afternoon and evening of Wed-



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Simple test sets for aid in controlling plating and other solutions.

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Specify Kocour Sets from your supplier.

nesday, February 27 at 2 p.m. and 8 p.m., respectively.

Throughout the week of February 25, there will be almost 200 meetings of ASTM technical committees including B-8 on Electrodeposited Metallic Coatings and D-1 on Paints, Varnish, Lacquer and Related Products.

R. J. Landon Joins Alsop Engineering Corp.

Robert J. Landon joined the Alsop Engineering Corp., November 1 in the capacity of Advertising Manager. He was released from the U. S. Maritime Service on October 15 after 34 months' service. Previous to entering the service he had eight years' experience in advertising, being formerly associated with the Chase Brass & Copper Co. in Waterbury, Conn.

H. W. Surbrook Appointed Detrex Comptroller

H. W. Surbrook has just been appointed comptroller of Detrex Corporation, Detroit 27, Mich., manufacturers of industrial cleaning machines and materials, and drycleaning equipment.

In announcing this advancement Mr. A. O. Thalacker, Vice President and General Manager, points to Mr. Surbrook's excellent record as head of the company's Accounting Department during the war.

In addition to being a Certified Public Accountant, Mr. Surbrook is a graduate of the University of Michigan, and a member of the National Association of Cost Accountants and the National Office Management Association. Prior to coming with Detrex he specialized in industrial accounting while associated with the public accounting firms of Parker-Elsholz, and Haskins and Sells.

Interesting Silicone Products

Although primarily intended for use in plastic molding, the Silicone products described in a new eight-page booklet, because of their unusual properties, may be of interest in some plating operations. By wetting and perferentially adhering to metal surfaces, these particular Silicones, known as DC Mold Release Fluid and DC 7 Compound, prevent the adhesion of rubber and organic plastics to treated metal and rubber surfaces. These materials are heat stable, water repellant and chemically resistant. Even tacky adhesives will not stick to Silicone treated surfaces. Write for Mold Release Bulletin, Dow-Corning Corp., P.O. Box 592, Midland, Mich.

Let Us Help You With Those Finishes

Having continued to serve the metal-finishing industry throughout the war, despite our own war work, we now offer unbroken years of experience and greatly expanded facilities to meet your post-war needs. If you are resuming production of pre-war articles or entering new fields, you are invited to bring your finishing problems to us.

Divine Brothers Company
INCORPORATED
POLISHING AND BUFFING
Engineering and Methods Specialists
Since 1892 **Utica 1, N. Y.**

Corrosion-Resistant Masonry Material and Construction Manual

Prepared by the engineering staff of U. S. Stoneware, this 52-page bulletin is replete with helpful facts and suggestions pertaining to materials and construction methods for tanks, towers, sumps, floors and other mansonry construction. Detailed information is given on physical properties and chemical resistance, on a wide variety of brick, tile and cements, together with practical, workaday suggestions for constructing masonry work. At-a-glance charts to help guide selection of the correct materials in a given job and tables of useful engineering data round this very informative literature piece. Write for Bulletin MR-810, U. S. Stoneware Co., Akron 9, Ohio.

Modern pH and Chlorine Control

A completely revised edition of the Taylor combination handbook and catalog, contains both simple and technical explanations of the meaning of pH control; specific discussions of the application of pH, chlorine and phosphate control to 35 industries; the precautions to be observed in making determinations; and descriptions of all Taylor outfits, including eight new sets. Copy free on request. W. A. Taylor & Co., 7300 York Rd., Baltimore 4, Md.

George L. Nankervis Company Moves Into Larger Offices

George L. Nankervis Company announces a change in address to 5442 Second Ave., Detroit 2, Mich., telephone: Temple 2-0362. The move, which triples office and engineering space, was forced by rapidly increasing volume of business resulting from post-war reconversion in customers' plants.

New Electronic Interval Timer

Electronic Controls, Inc., 44 Summer Ave., Newark 4, N. J., announces a new electronic timer suitable for all applications requiring highly accurate circuit timing.

Time range is from 1 to 120 seconds in increments of one second. Accuracy better than 5%. Unit is housed in an attractive slope front steel cabinet with handsome crackle finish. Two dials are pro-

RECOVER SOLVENTS

Recover Solvents and Thinners from Wash, Stripping, and Degreasing Operations by the well-known

LOFGREN PROCESS

Send quart sample of soiled solvent to

CRANE EQUIPMENT & SUPPLY COMPANY
P. O. Box 16
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SOLVENTS RECOVERY SERVICE, Inc.
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ACID AND ALKALI PROOF LININGS AND MORTARS

•

ACID PROOF CONSTRUCTION

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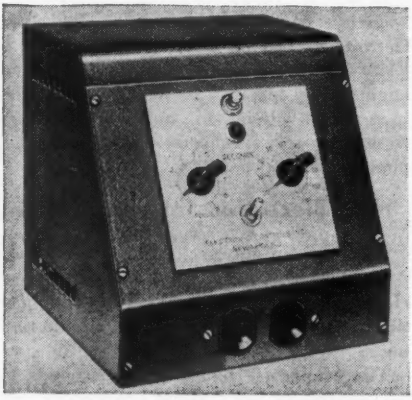
THE CEILCOTE CO.
Consulting and Research Engineers
750 ROCKEFELLER BLDG.
CLEVELAND, OHIO

vided for time selection — one calibrated in single seconds, the other in 10 second steps. Dials control tap switches. Unlike potentiometer control, the snap-positioning step-switches assure precision control, with exact values of resistance inserted in the circuit at each position. A pilot light, toggle on-off switch and a push-switch are included.



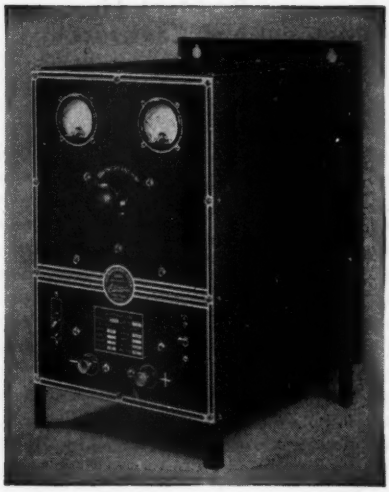
A double receptacle permits timing two circuits simultaneously. Contacts are normally wired SPDT with double break and are rated at 25 amps 32VDC, 25 amps 125 VAC and 10 amps 230VAC. Contacts can be wired DPDT at correspondingly lower rating.

Cabinet size is 8x8x8 inches. Tube used is a 2050 thyratron. High accuracy resistors assure precise timing and timing is independent of the length of time the tripping push button is depressed. Dial switch is provided with a position for continuous circuit closure. The unit is compact, easy to operate and is supplied for 115VAC operation.

The timer recommended for all photographic and industrial applications requiring precise time control has applications in control of plating, tumbling barrels, etc.

New Line of Variable Rectifier Equipment

The Rectifier Division of Richardson-Allen Corporation, 15 West 20th St., New York, N. Y. announces a new general purpose line of Rectifiers particularly adapt-



able in the field of electro-chemical applications, such as: electroplating, electro-cleaning, electro-anodizing, electro-descaling, electro-pickling, electro-colorplating, and for general laboratory use.

The first three models, all designed around the Selenium rectifier, operate at: 25 amps., 6 volts, convection cooled, 14"h.x 8"w.x12"d.; 37/75 amps., 12/6 volts, and 75/150 amps., 12/6 volts, fan cooled, 22½"h.x14"w.x14"d., respectively.

Selenium Rectification or Tube Rectification of variable single, and double units, from .1 to 300 amps., up to 20,000 volts. Extensively regulated and/or filtered.

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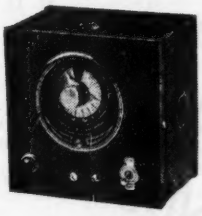

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(Continued on next page)

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(*Continued from preceding page*)

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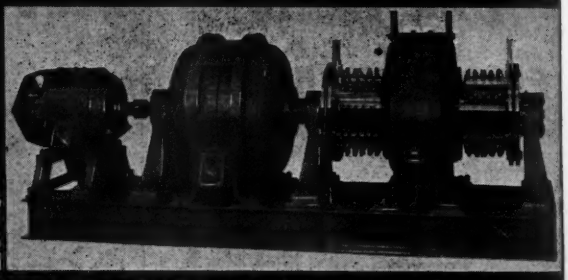

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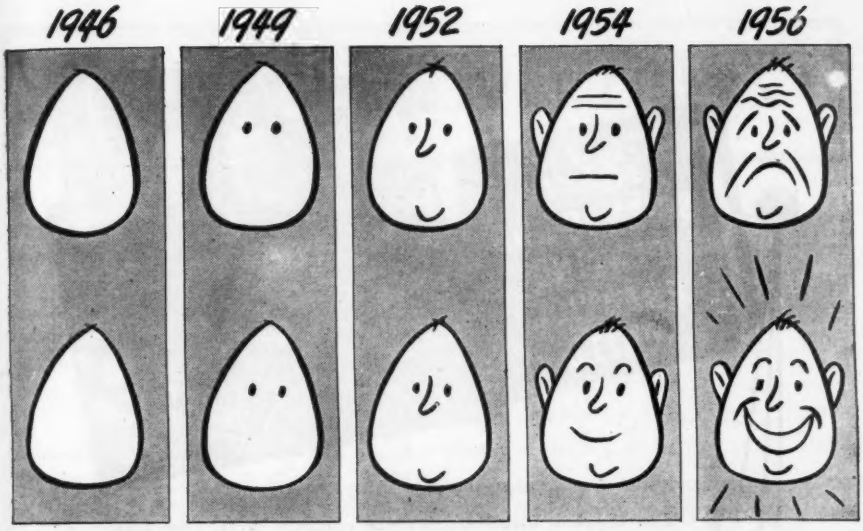

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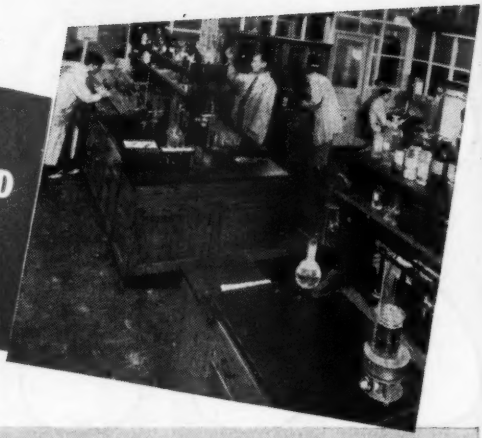

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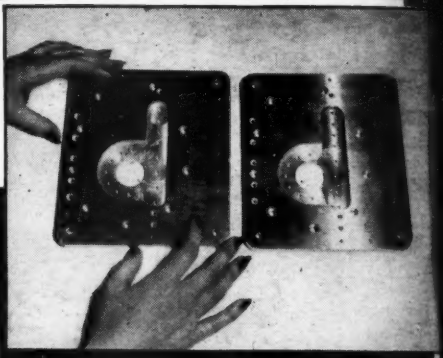

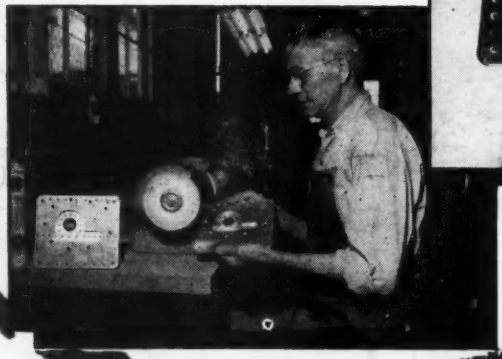

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